THE POPULAR JOURNAL OF KNOWLEDGE

DISCOVERY

CAMBRIDGE: SEPTEMBER 1939

- EARLY SHIPS AND SHIP BURIALS
- CHINA'S NEW ROAD
- ENERGY FROM MATTER
- SECRETS OF CAMOUFLAGE

(*for full list of contents see page* iii)

DISCOVERY

SEPTEMBER 1939 *New Series, Vol. II, No.* 18

Published by CAMBRIDGE UNIVERSITY PRESS, 200 Euston Road, N.W. 1 (Tel.: Euston 5451–3)
Editor: C. P. SNOW, University Press, Cambridge (Tel.: 4226)
Advertisement Offices: 61 Chandos Place, W.C. 2 (Tel.: Temple Bar 6008)
Annual Subscription, 12*s.* 6*d.* net post free
Sole agents in the U.S.A.: The Macmillan Company. Annual Subscription $4.00
Sole agents for South Africa: Central News Agency (London agents: Gordon & Gotch)

A New Means of Destruction?

SOME physicists think that, within a few months, science will have produced for military use an explosive a million times more violent than dynamite.

It is no secret; laboratories in the United States, Germany, France and England have been working on it feverishly since the Spring. It may not come off. The most competent opinion is divided upon whether the idea is practicable. If it is, science for the first time will at one bound have altered the scope of warfare. The power of most scientific weapons has been consistently exaggerated; but it would be difficult to exaggerate this.

So there are two questions. *Will* it come off? How will the world be affected if it does?

As to the practicability, most of our opinions are worth little. The most eminent physicist with whom I have discussed it thinks it improbable; I have talked to others who think it as good as done. In America, as soon as the possibility came to light, it seemed so urgent that a representative of American physicists telephoned the White House and arranged an interview with the President. That was about three months ago. And it is in America where the thing will in all probability be done, if it is done at all.

The principle is fairly simple, and is discussed by Mr D. W. F. Mayer in more detail on p. 459. Briefly, it is this: a slow neutron knocks a uranium nucleus into two approximately equal pieces, and two or more *faster* neutrons are discharged at the same time. These faster neutrons go on to disintegrate other uranium nuclei,

and the process is self-accelerating. It is the old dream of the release of intra-atomic energy, suddenly made actual at a time when most scientists had long discarded it; energy is *gained* by the trigger action of the first neutrons.

The idea of the uranium bomb is to disintegrate in this manner an entire lump of uranium. As I have said, many physicists of sound judgement consider that the technical difficulties have already been removed; but their critics ask—if this scheme were really workable, why have not the great uranium mines (the biggest are in Canada and the Congo) blown themselves up long ago? The percentage of uranium in pitchblende is very high: and there are always enough neutrons about to set such a trigger action going.

Well, in such a scientific controversy, with some of the ablest physicists in the world on each side, it would be presumptuous to intrude. But on the result there may depend a good many lives, and perhaps more than that.

For what will happen, if a new means of destruction, far more effective than any now existing, comes into our hands? I think most of us, certainly those working day and night this summer upon the problem in New York, are pessimistic about the result. We have seen too much of human selfishness and frailty to pretend that men can be trusted with a new weapon of gigantic power. Most scientists are by temperament fairly hopeful and simple-minded about political things: but in the last eight years that hope has been drained away. In our time, at least, life has been impoverished, and not enriched, by the invention of flight. We cannot delude ourselves that this new invention will be better used.

Yet it must be made, if it really is a physical possibility. If it is not made in America this year, it may be next year in Germany. There is no ethical problem; if the invention is not prevented by physical laws, it will certainly be carried out somewhere in the world. It is better, at any rate, that America should have six months' start.

But again, we must not pretend. Such an invention will never be kept secret; the physical principles are too obvious, and within a year every big laboratory on earth would have come to the same result. For a short time, perhaps, the U.S. Government may have this power entrusted to it; but soon after it will be in less civilized hands.

THE EDITOR

CHINA'S NEW ROAD

By Gregory Stapleton

YUNNAN is a remote province, and a poor one at that, nor is there any apparent reason why it should interest anyone but the Yunnanese. Its western border lies close to the long, navigable reaches of the Irrawaddy, and only through here can Szechuan and the rich provinces of the Yangtse find an alternative way to the sea—a way which cannot be obstructed from the eastern side. Railways have been surveyed and plans worked out, but always there has been the question of cost. With cheap, or free labour, roads are a different question, and require none of this great outlay of capital, so, recently in the period of comparative political calm a start was made on the construction of the roads, and even now, the work goes on. Already from Yunnan-fu, the capital, 250 miles to Tali, the great centre of the west, the road is open and daily the lorry convoys leave, following the ancient route of the caravans returning to Burma for cargoes of jade.

It was along this road that we were bound. It should, by rights, have been unusable for motor traffic as the surface is still mostly mud, and when the rains start at the end of June it quickly becomes impassable, but that year, though it was the end of July, the rains had not really broken and we had hopes of doing in two days a journey which would take at least twelve by caravan.

We started three hours late. That is nothing in Yunnan, where everything starts at least two hours after it should. However, there was good reason this time, as the rain seemed to have decided to come at last, and to make up for lost time; it came down in continuous, unremitting torrents. There was no advantage to be gained, by making a start, only to be bogged a few miles outside the town, and with none of the comforts which Yunnan-fu boasts. Luckily, after a time the rain ceased, and we lost little time in getting away. Two officials delayed us in the city by demanding our passports, which were

The new road to Tali being laid

A rough piece of road

We build our bridge

The road in a good spot

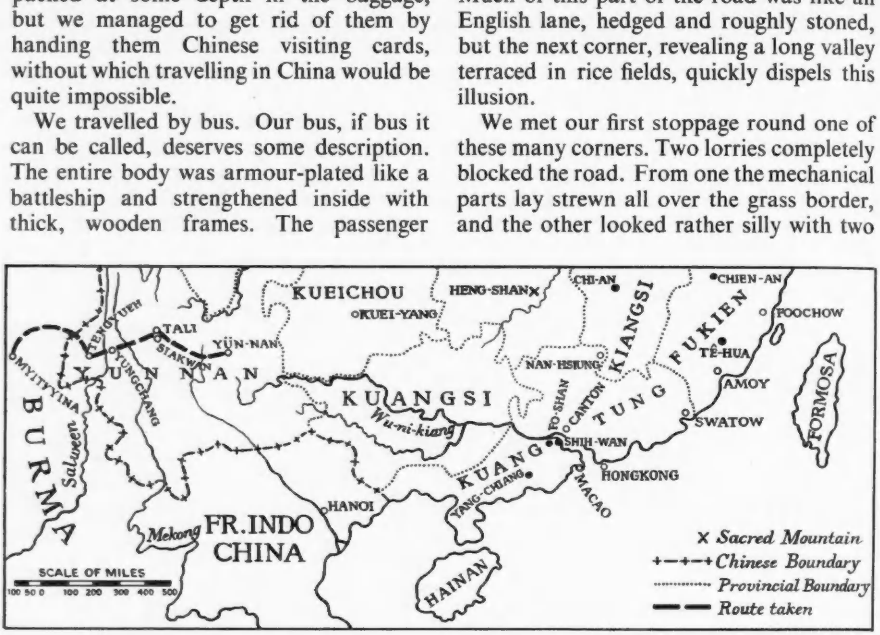
packed at some depth in the baggage, but we managed to get rid of them by handing them Chinese visiting cards, without which travelling in China would be quite impossible.

We travelled by bus. Our bus, if bus it can be called, deserves some description. The entire body was armour-plated like a battleship and strengthened inside with thick, wooden frames. The passenger accommodation, though just sufficient, was hardly of the *Queen Mary* standard, as it consisted of a single wooden bench, about 8 in. wide, sandwiched between the driver and the cargo. To prevent us getting mixed up with either the one or the other in the event of trouble, spiked rails of the park fencing type enclosed this space. It added, if not to the pleasure, at any rate to the interest of the trip, to realize that these precautions were very possibly the fruit of experience.

The first 60 miles is now becoming quite old, and beyond being painfully bumpy in parts was not very eventful. The country is one of huge hills and valleys, and the first sharp rise gave a magnificent view of the great Yunnan-fu lake stretching 20 or 30 miles to the south. Close under the hills the surface was a deep shade of blue, broken here and there by little bright patches, which were the sails of sampans. Much of this part of the road was like an English lane, hedged and roughly stoned, but the next corner, revealing a long valley terraced in rice fields, quickly dispels this illusion.

We met our first stoppage round one of these many corners. Two lorries completely blocked the road. From one the mechanical parts lay strewn all over the grass border, and the other looked rather silly with two completely blown back tyres. By means of a good deal of arm waving and a little swearing, we managed to persuade the lorry of the blown tyres to back sufficiently to let us pass. It was at least consoling to know that the large spare spring and pick-axe which, being stowed in the limited passenger space, added somewhat to our discomfort, had a sound reason for their existence.

Around here the road crosses a great number of steep gullies, often 40 or 50 ft. deep. The authorities intend in time to span them with stone bridges, but as yet many are not completed and the original wooden affairs are still in use. They are large scaffolding contraptions and very rickety. Crossing was at first exceedingly exciting, as, in addition to the obvious ricketiness, there were always large holes in the road surface giving an excellent view of the bottom of the gulley where



Map showing Yunnan and Tali

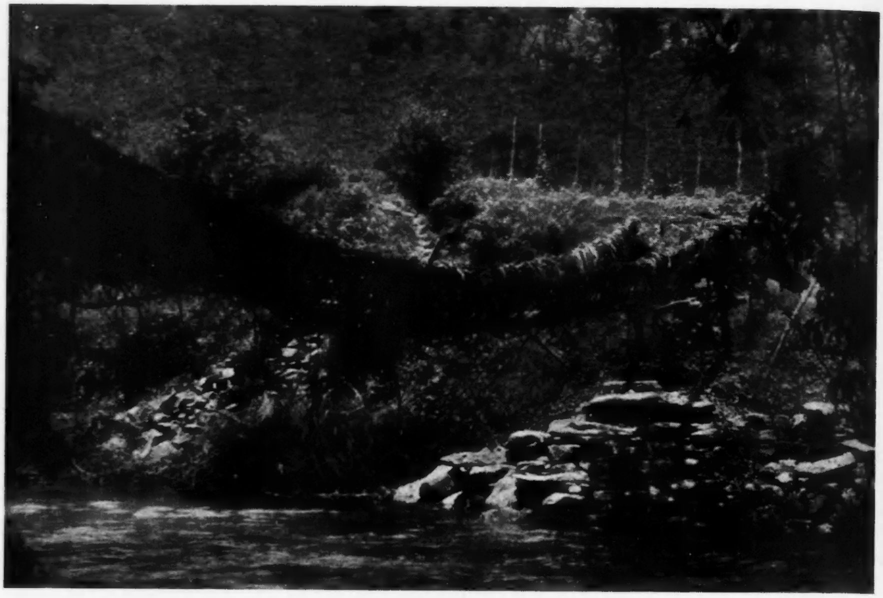
one expected to arrive precipitately at any moment; we attributed their mysterious power of supporting an exceedingly heavy loaded lorry as another proof that the West has yet much to learn from the East.

That night we had our first experience of Yunnan inns. Later we learnt that these are of two kinds, both having one thing in common—they enclose the stable yard. Their difference is that in one class of inn one can live by oneself in a loft which at other times is used for the storing of grain and forage; in the other class one shares a room below with all and sundry other travellers. In the first case one is literally among the gods, for up in the loft is usually erected the altar of the household gods. The stable yard is the habitat of several pigs, a number of cows and a lot of chickens, but as one usually gets in late and is off very early the main disadvantage is the smell.

Our inn was in a garrison town. Most of the towns have garrisons of one sort or another, as in these hills it is a choice between garrisons or bandits and, perhaps, garrisons are preferred. (The only bandits we saw on this part of the trip turned out to be village guards armed with decrepit muskets.) After settling in, we were visited by the guard, two men and an N.C.O. Europeans staying at the inn were undoubted rarities and worthy of military suspicions or at least curiosity. Whichever it was the interview must be conducted properly. The first move was the offering of a cigarette to the N.C.O. This was no casual handing of a cigarette case; that would have betrayed us at once as men without manners or education. The correct way to offer a cigarette is, of course, in the fingers, while he, being a man of manners, naturally refused the light we offered but must take the match in his own fingers and, incidentally, burn himself in the process. A friendly atmosphere being now established, we settled down to conversation. This consisted of rapid Chinese on the N.C.O.'s part, and on ours

Muddy going!

a good deal of nodding and what, I hope, were pleasant smiles. Whether they were or not, a few minutes of this conversation sufficed either to bore the N.C.O. or to establish our *bona fides*, for he left us and we saw him no more.



A bridge near Tali

Solid-wheel bullock carts—the only wheeled traffic known in the city until the advent of motor buses

Pumping water for rice fields near Yunnan-fu

A town on the Yunnan-Tali road

Most of the soldiers of Yunnan are cheerful, friendly fellows. We met some one day, returning from a game of football, outside a town called Shachao. We took a photograph of the group which pleased them so much that they insisted on our coming back with them to see their barracks. Shachao is more full of flies than any town we saw, not that the others were by any means flyless. In Shachao one had the impression of moving through a dense cloud of locusts to the accompaniment of the music of a large buzz-saw. The barracks, which were outside the town in a large Chinese house, were, in distinct contrast to the town, pleasantly clean, and the paths to the parade ground were bordered with little flower-beds. So much for military training! Our reception at the barracks was enthusiastic, but when we saw clean shirts being quickly issued it became evident that the enthusiasm was not entirely for the pleasure of our company. Of course cameras are a rarity in Shachao, and a chance of having the company photographed was not one to be missed.

Soldier-footballers from Yunnan

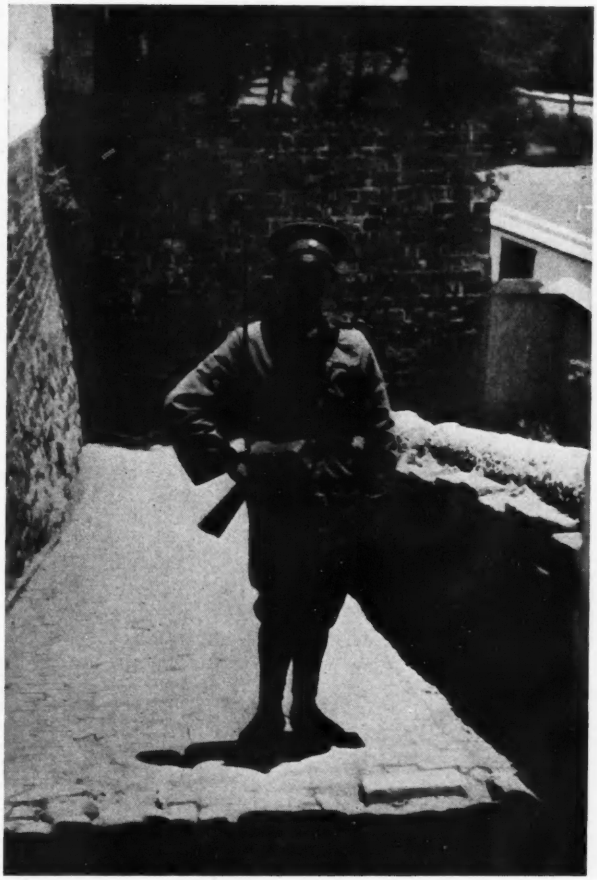
The photograph parade was a pleasant, friendly affair except for the sergeant-major, who, true to type, was rather rude. The parade began by numbering, the numbers being passed down the line of men rather as if each was giving some confidential and intimate information to his neighbour. The higher numbers were the cause of some difficulty, but as some of these men had seen battles in half a dozen campaigns, numbering isn't, perhaps, so very important. We photographed the parade and then visited an exhibition basketball game which we photographed as well. Finally, we photographed the officers. Everyone was very pleased and we made a triumphant departure amid salutes and bowing smiles.

It rained all that night at Shachao, but luckily these mountain streams sink to reasonable proportions almost as quickly as they rise, and the stream we came to though too big for the lorry to ford was easy to bridge. Again, luckily, the authorities evidently had had doubts of this particular structure, and there was a nice pile of timber lying near and easy to hand. The bridge we built was a very good one, with beams longitudinally and transversely. The lorry driver either had a childish faith in our engineering capacity, or was merely a confirmed fatalist, for he took the lorry over like a bull at a gate. This was, apparently, the correct move, for the rush took him safely up the far bank and on to

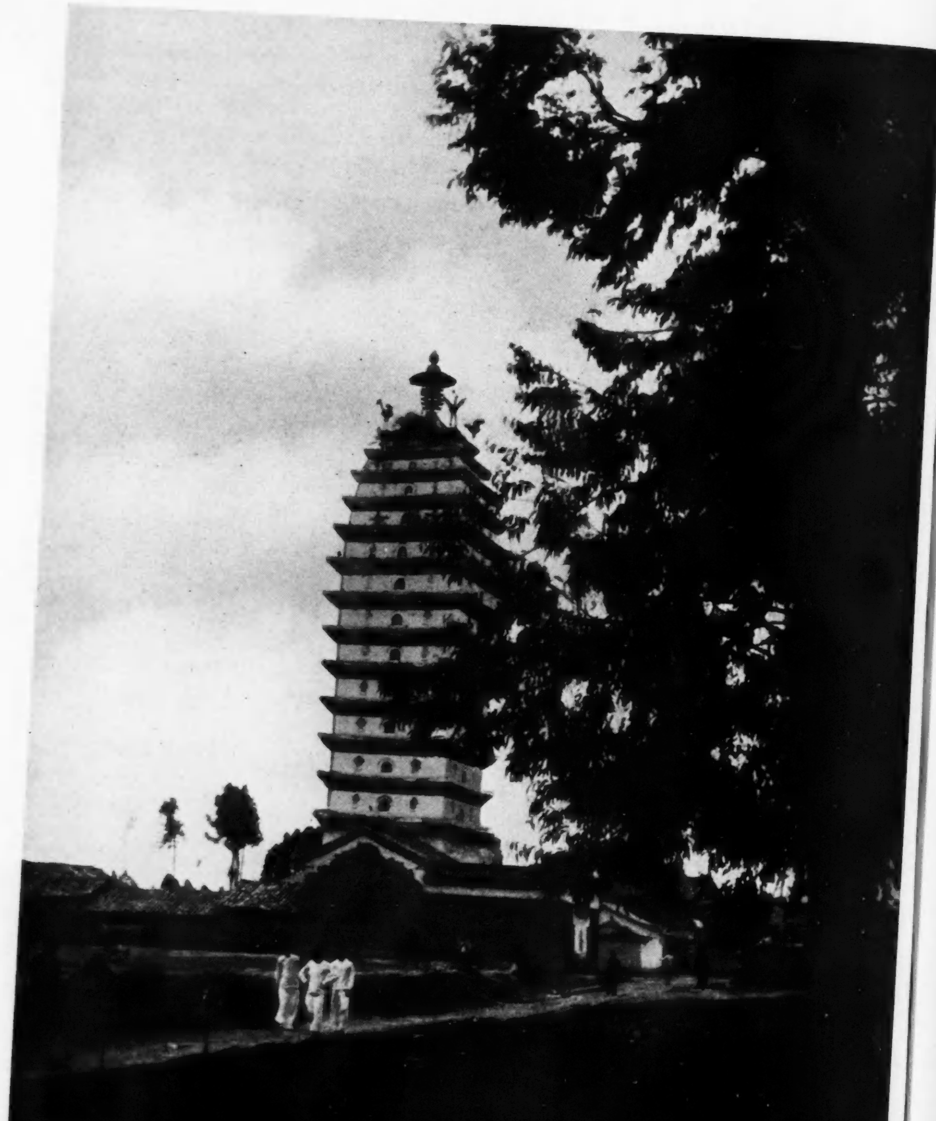
the road beyond. Another bus had come up with us now, and its driver, seeing the success of this manœuvre, prepared to do likewise. Unfortunately, in his desire for speed, he overlooked the extreme narrowness of the bridge. A back wheel went too far over. It took us about an hour to get him out. We got plenty of labour, as all Chinamen love any excuse to make a crowd, especially if they can shout and make plenty of noise. This, of course, was just the thing, and the local villagers were round in force as fast as their legs could carry them. Some got behind the bus and pushed, some just shouted. The bus went up the slope and slipped down again. Everyone shouted. This happened two or three times. It looked as if it might go on all the morning, but no one would hear of getting some of the cargo out to lighten her. They were right, of course, for they did, in the end, get it up on the road. There we left it rather hurriedly to any further fate.

As we advanced towards Tali the road became progressively rougher and more newly made and in consequence, also progressively, more painful to travel upon. As a feat of engineering it is impressive. These mountains run north and south from the Himalayas, so that the road cuts straight across them. The day's run was a series of terrific climbs, sometimes 2000 or 3000 ft., followed by equally terrific descents. From the summits one would get a magnificent view over miles of wooded country, and then descend in a series of sickening S-bends into lovely little valleys—that is, lovely to look upon. They had disadvantages that were not so lovely.

The valley of Honie was perhaps the most beautiful of all. It is 3 or 4 miles broad and, lying between long ranges of mountains, stretches into the distance to the south. From the hills the brown roofs of little villages show pleasantly in contrast to the green of the trees and the rice-fields, and the white criss-cross of streams. But once in the valley itself the disadvantages went far to outweigh the pleasure



A sentry on the walls of Yunnan-fu



Ming pagoda at Yunnan-fu

of its bea
the culti
unmetall
soon gav
As we re
sank up
once, an
operation
axe, we
under wa
only to
violently
yards, be
embedded
position
hopeful, h
were piles
side of th
gang of
away at t
coolies ha
ideas of Tr
Chipping
and chipp
going to d
the entire
nan-fu to T
but a line of
in the mud
tion betwe
crew, back
sengers, a
foreman,
supported
rapidly grev
We retired
where, not
get a better
sible hostilit
not be drav
warfare with
tants of the
judging by th
be our home

One of the
some politica
hostilities, by
labouring the
From that,
general. The

of its beauties. Rich fertile soil suitable for the cultivation of rice is no place for an unmetalled road in the rainy season. Honie soon gave us a taste of what was to come. As we reached the floor of the valley we sank up to the back axle in mud almost at once, and when, after extensive digging operations with the pick-axe, we managed to get under way again, it was only to skid and slither violently a few hundred yards, before being firmly embedded again. The new position was rather more hopeful, however, as there were piles of stones by the side of the road, and a gang of coolies chipping away at them. But these coolies had very strong ideas of Trade Union rules. Chipping was their work, and chipping they were going to do, no matter if the entire road from Yunnan-fu to Tali was nothing but a line of cars half buried in the mud. The conversation between the lorry's crew, backed by the passengers, and the coolie foreman, enthusiastically supported by his gang, rapidly grew acrimonious. We retired to the lorry where, not only could we get a better view of possible hostilities, but could not be drawn into open warfare with the inhabitants of the valley, which, judging by the look of the road, might well be our home for some time to come.

One of the passengers, a young fellow in some political uniform, actually began the hostilities, by seizing a long hoe and belabouring the foreman in no uncertain way. From that, the action rapidly became general. The uniformed young fellow proved like Ajax in the fray, and having quickly subdued the foreman, turned on all and sundry with equal good will. It ended with the coolies getting the lorry out and liberally covering the road with their stones to help us on our way, but all to no avail, as a bit farther on the road was

The modern main road at Yunnan-fu

definitely and completely blocked by two half-submerged lorries bound from Tali. There was nothing for it but to stay the night. The driver professed his faith that the wonderful effects of morning sunshine and a drying wind would make the road passable in the morning. To us it was obvious that faith alone would not be

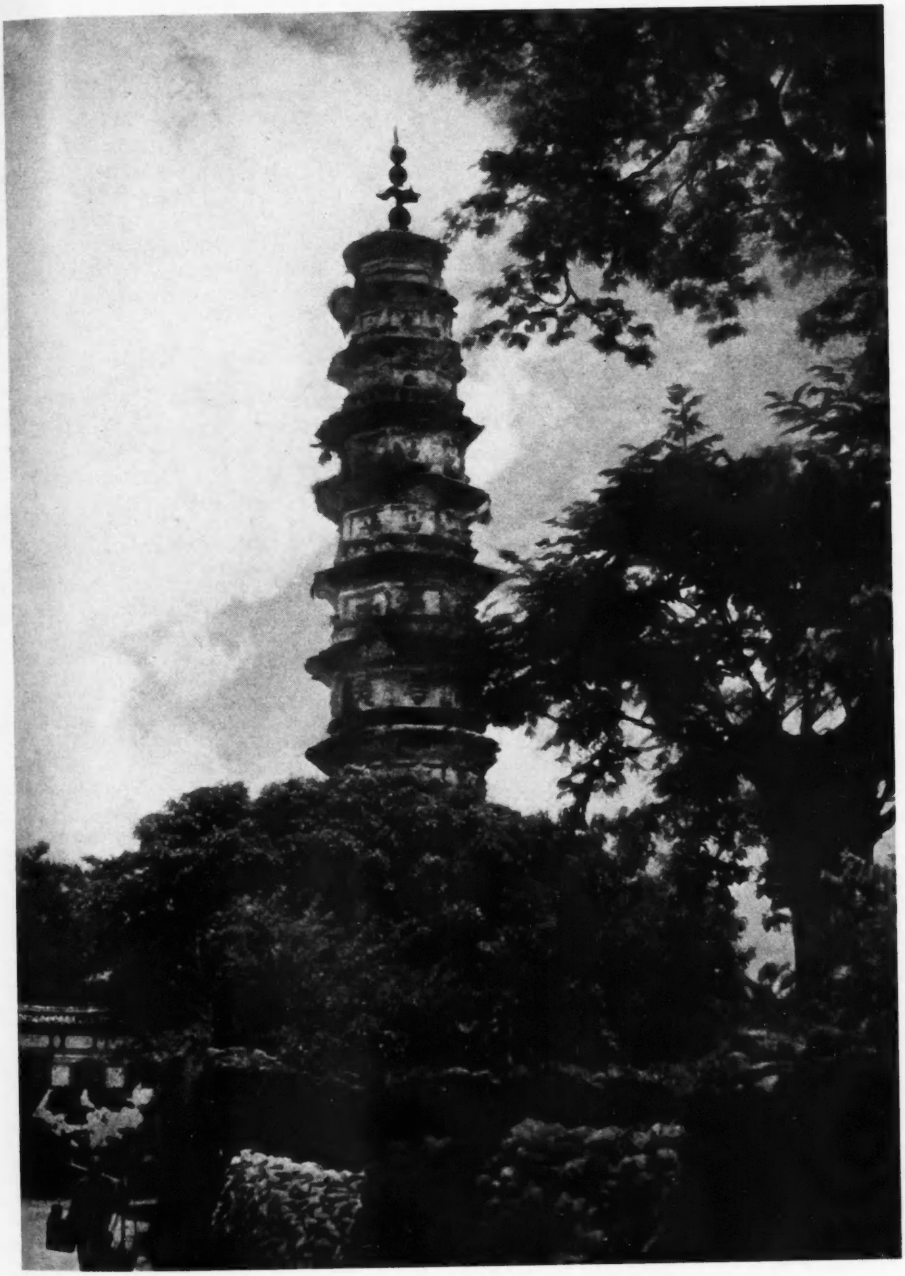
sufficient, so we added the horrid threat that, failing progress in the morning, we would leave the lorry and go on our way by mule caravan, thereby causing the driver no little loss of face. The next day by midday

An ancient on the Tali road

we were away, though not without difficulty, repeated threats and some swearing.

That night we drove triumphantly into Hsiakwan, four days out from Yunnan-fu. Hsiakwan is about 7 miles from Tali and the bus goes no farther, for it is the meeting place of the caravan roads from Tibet and Szechuan, and from Yunnan-fu and Burma. It is a busier and more cheerful place than any we met, its narrow streets full of jostling crowds, mules and motor lorries. In the shops one can buy anything from the cheap clocks and torches of Hongkong or Shanghai to fine pelts and furs from the mountains. But for us there was little time for shopping or sightseeing. A bare two hours of daylight remained and 7 miles to do in what, by courtesy, is called a chair. This conveyance consists of two long bamboo poles separated by a string contraption, into which the traveller fixes himself. The feet rest on a slung bar in front, so that the knees stick up. The whole is slung on the shoulders of coolies, and aided by a pillow or two and a kitbag to support the shoulders is not too uncomfortable.

At the inn where we dumped our heavy baggage they tried hard to make us stay the night. "Bad men with guns on road. No can go." This piece of information we treated with the contempt it deserved; as an excuse it is as old as the hills of China. At any rate it would have taken a lot of bad men on the road to keep us from Tali where there were friends and some, at least, of the amenities of civilization. Once out of the city gates the story was even more obviously absurd. Never a more peaceful scene could there be; a narrow stone-flagged path wandered among the fields, and here and there, along it, little groups of peasants were walking slowly



Ming pagoda at Tali

towards their villages. Below stretched the huge sheet of the Lake of Tali, 40 miles in length. Close on the other side rose sheer 14,000 ft. of mountain range. Every mile or two we passed through a little village, the lights here and there showing in the dusk. It was dark by the time we reached Tali, and darker and eerie among the houses, for much of this town we had reached at length had been ruined by a great earthquake a few years ago.

The Burma-Yunnan road is now open from Yunnan-fu to Lashio.

Energy from Matter

By Douglas W. F. Mayer

The possibility of making use of the latent energy of the atom is one that has fascinated technicians ever since it was first realized that our natural sources of power are limited. Although we are not yet able to say that atomic power is "just around the corner", there are indications that a step forward towards attaining it has been made during the last few months. Already, in New York, atomic power has been used to start chemical reactions, whilst in France, scientists engaged in research on this topic are getting worried at the thought of liberating energy in sufficiently vast and sudden quantities to blow them and their apparatus out of existence.

The chain of discovery which led up to this position began in March 1934, when Prof. E. Fermi, of the Royal University of Rome, found that the bombardment of uranium with neutrons gave rise to new radioactive elements. Neutrons are exceedingly small subatomic particles, which have no electrical charge, and have thus great penetrating power.

Previously, uranium had been regarded as the element with the greatest atomic weight and atomic number in existence, but chemical tests of the new, short-lived unstable elements led scientists to the conclusion that they possessed greater atomic weights and numbers, and the name trans-uranic was given to them. The atomic number, which for uranium is 92, denotes the number of electrons in the atom which rotate round the nucleus. The new elements were thought to have atomic numbers of 93, 94, 95 and 96, and were labelled accordingly eka-rhenium, eka-osmium, eka-iridium and eka-platinum. It is said that Fermi proposed to christen number 93 "mussolinium", in honour of Il Duce, but thought better of it when he realized how unstable it was.

For over four years the properties of these trans-uranic elements were studied in Europe and America, altogether ten new elements being produced. The tenth of these was found in Paris, last summer, by Madam Curie-Joliot, daughter of the famous Madam Curie. With her collaborator, Savitch, she made a careful investigation of the new bombardment product. This investigation led them to the conclusion that no new element had been produced, and that the substance under analysis was none other than the "rare earth" element lanthanum.

Learning of this discovery, Hahn and Strassman, of Berlin, were prompted to make careful tests of the other bombardment products, to see if they, too, might really be ordinary elements with atomic weights less than that of uranium. They found, at the beginning of this year, that short-lived isotopes of both barium and lanthanum were produced by the bombardment of uranium. The isotopes of an element have identical chemical properties with the element, but possess slightly different atomic weights.

Here was something new to atomic physics. Previously, all bombardment of atoms had resulted in small lumps being chipped off. Now, however, the neutrons were hitting the uranium nucleus right in the middle and cracking it into two almost equal-sized fragments, the fragments being atoms of elements with medium atomic weights.

Further research by other workers showed that the remaining bombardment products, which for four years had been accepted as being trans-uranic, were also none other than normal elements or their isotopes. Thus the two products previously described as eka-iridium and eka-platinum were identified as tellurium and iodine

respectively. In fairness to the former investigators, it should be pointed out that they were handicapped in their identification of the elements by the fact that these were produced only in small quantities, and were very unstable.

Whilst details of the new discoveries were being assimilated by scientists throughout the world, a study was made of the exact nature of the uranium disintegration, or "fission" as it was called. Calculations by Meitner and Frisch showed that part of the mass of the uranium nucleus would vanish, giving rise to bursts of energy, and Frisch later showed, by a purely physical method, that the fission of the uranium did occur and that the predicted amount of energy was released.

In making a further study, Dr F. Joliot, the husband of Madame Curie-Joliot and sharer with her of a Nobel Prize, with his collaborators at the Collège de France, came across even more exciting results. The neutrons used in the initial bombardment of the uranium were what are known as "thermal" neutrons: that is to say, they possessed low energies roughly equal to the thermal energy of ordinary molecules. But Joliot found that at the moment of fission of the uranium nucleus, new, fast-moving neutrons were emitted—neutrons with energies of at least eleven million electron-volts! The uranium, bombarded with slow neutrons, was emitting fast ones!

In their initial experiments, Joliot and his collaborators used only minute pieces of uranium, and consequently the neutrons, which can penetrate even metals for some distances, were able to escape. But, they asked themselves, what would happen if the neutrons were liberated in the centre of a lump of uranium sufficiently large to prevent their escape? Would there be sufficient neutrons to cause further nuclei to break up, thus liberating more high-energy neutrons, and so starting a chain reaction? Theoretical considerations showed that there would be, and the question now troubling the French investigators is, how can they control such a reaction?

Mindful, perhaps, of imaginative stories of scientists who start atomic reactions and cannot get them to stop, and of the fact that, even supposing only one four-hundredth of the uranium is converted into energy, one ounce of uranium will produce sufficient energy to boil about one thousand tons of water, the French scientists can be excused a little trepidation in continuing their work. Adler and von Halban, of the Collège de France, have stated: "The danger that a system containing uranium in high concentration might explode, once the chain is started, is considerable." Recently, however, they have been investigating a method of controlling the process, by means of diluting the uranium with an absorbent, such as cadmium, and further research on the question of the liberation of energy is now proceeding. Let us hope, for their sake, that the dilution process works.

Meanwhile, experimenters in New York have demonstrated that even in its present stage, sufficient energy can be obtained from the uranium fission to cause, some distance away, the decomposition of nitrogen iodide, an unstable chemical compound. Before optimistic speculators rush on ahead, however, let us point out that atomic power on a practical scale is still at present as far away a dream as ever, though we can, if we like, regard the first steps towards the realization of the dream as having been taken. Those who wish to speculate can ask themselves what society will make of atomic power should it come in the next century or so. Will it create a streamlined world where a pinch of salt is sufficient fuel for the *Queen Mary*, or shall we have a Wellsian chaos with each nation dropping bouquets of uranium bombs in a policy of encirclement?

The Ancient History of the Ship

By D. H. C. Birt

(*"Sometimes the body of a lord was placed in his ship...." The discovery a few weeks ago of the ship burial relic at Sutton Hoo throws an interesting light on Mr Birt's article. A detailed account of the new find is given in "Notes of the Month," page* 479.)

MAN's consideration for the future does not usually extend beyond the span of his own life, and he is not usually over-anxious that any records of his own times should be preserved for the benefit of posterity. Indeed, ancient man who carved pictures on rocks was better in this respect than his civilized successors. To-day detailed histories of ships may be read, but seldom is the painstaking research that made them possible appreciated. The work of the nautical archaeologist is rendered specially difficult owing to the perishable nature of a ship's timbers, and it is not always realized that very large gaps exist where contemporary evidence of shipping is both scarce and unreliable. As a well-known nautical archaeologist wrote: "...it seems desirable to indicate how capricious have been the survival of exact facts, and how large are the gaps." In spite of this, the skilled investigator is able to reconstruct much on only a little data. While ships have changed, the elements of seamanship and the action of the wind and sea have remained unaltered.

Man, no doubt, lived for a very long time indeed before he had the idea of venturing afloat even clinging on to a log of wood, while the ship in its crudest form certainly existed long before the arts of drawing and writing were born. The first substantial records of shipping are to be found in that cradle of civilization, Egypt, but by this time the ship was in a well-developed state, and the use of the sail had been discovered. That the sailing vessel had been long in existence even at the time of the oldest records there can be little doubt, but it is unlikely that evidence of these ancient boats will ever be found.

Until recent times our knowledge of ancient Egyptian civilization was based mainly on the old Greek and Roman writers. The middle of the nineteenth century saw the beginning of the scientific study of Egyptian remains, the excavation of temples, palaces and monuments, and the translation of hieroglyphics. Some of the earliest pictures of ships were found on the pottery obtained from these excavations. The ship being one of the major influences in the life of the Egyptians was a popular decoration for vases, and the earliest of these representations has been dated as earlier than 4000 B.C. Considering that pictorial art was then in a very primitive state, peculiar crescent-shaped designs on some earlier vases were once supposed to be ships. To-day, this is regarded as improbable, especially since on one specimen of the pottery of the period there is quite a good picture of a sailing vessel, showing that the ship was not entirely beyond the capacity of early Egyptian artists.

Other vases of later period show ships in detail. One is immediately struck by the size of these vessels, but here allowance has to be made for the idiosyncrasies of the ancient artists. It was an Egyptian convention to portray both sides of an object at the same time, while things were twisted round or misplaced without consideration for the laws of perspective, in order to show them better or prevent them being masked. Likewise, artists unwilling to lose part of their ships under the water-line showed them higher out of the water than was really the

(From a Model in the Science Museum, South Kensington. Reproduced by permission of R. Morton Nance, Esq.)

The Carrack ship (*about* 1450 A.D.)

case, this causing undue height and lack of proportion in their pictures.

Boats are often represented in the paintings and bas-reliefs of the temples and tombs of Ancient Egypt. The wall pictures are accurate, and show the usual fine detail, obviously being done by artists who understood their subject. This is hardly to be wondered at, considering that every Egyptian must have been thoroughly conversant with the ships that plied daily up and down the Nile.

Contemporary ship models placed in the tombs for the fanciful purpose of giving the deceased a means of sailing the streams of the underworld, have in a few cases survived

until to-day. Unfortunately the shape of their hulls was contorted so as to provide a flat base on which to stand, thus seriously detracting from their historical value.

After the decline of the Egyptians as a seafaring nation, came the Phoenicians, Greeks and Romans, each with their characteristic ships. Of these, records similar to those of Egypt exist, the ship remaining a popular subject for the decoration of vases, while in the case of the Romans the great classical writers can give some information. History has little good to say of the Romans as seamen, but as ship-builders they probably excelled the Vikings, in spite of the exaggerated opinions sometimes expressed of the latter ships.

Greece presents one of the most controversial problems pertaining to ancient ships, but this is too long a subject to receive here detailed consideration. Briefly, the problem concerns the arrangement of the oars and oarsmen in the Greek galleys. The idea held by most people since their school days is that the triremes had three superimposed banks of oars, the quinqueremes five banks, and so on. So common is this idea that it may come as a surprise that it is a highly improbable explanation of the working arrangement of the oars. Indeed, it is unlikely that superimposed banks were ever in use at all.

While the Mediterranean peoples had reached a state of civilization comparing favourably with our own to-day, those of northern Europe were still barbarians. Yet, strange as it may seem, far more exact information is available of their ships than of the more highly cultured southern folk.

Primitive rock carvings of ships of this age, similar to but cruder than the representations on the pre-Dynastic vases of Egypt, exist in large numbers along the coast of Sweden and Norway. These carvings, however, are art in its crudest form—merely a picture language which conveys little to the twentieth-century mind. Occasionally there are unusual features which might represent important developments in naval architecture, but which are more probably mere crude artistry.

The present knowledge of early northern ships is derived almost exclusively from actual remains which have been discovered in various countries. It is strange, but the further one delves into the past from the present day, the more common becomes this most infallible and incontrovertible evidence.

Owing to the absence of big trees, the dug-out type of ship hewn from a single trunk was never seen in the Mediterranean, though this more primitive style of shipbuilding persisted in the north. In 1833 remains of this kind of vessel were found in Arun in Sussex, while in 1886 another large relic was discovered at Brigg in Lincolnshire. It is usual to refer to those remains

(By courtesy of the Science Museum, South Kensington)

Ship on the seal of John, Duke of Bedford, (about 1450 A.D.)

by the name of the place where they were found. The Brigg ship was found during the construction of a gasometer for the Brigg Gas Company, and a long lawsuit ensued as to the ownership of the relic. The boat is of huge dimensions, and for this reason was refused as an exhibit in the British Museum. Its size is of special interest, for no tree large enough to construct such a craft has

(*By permission of Universitetets, Oldsaksamling, Oslo*)

The Gogstad ship. Note the excellent state of preservation

existed in this country for centuries. In this vessel there is even evidence of the internal arrangement, and this, together with many similar ones found in other European countries, affords a good record of primitive northern ships.

Gradually the plank-built ship superseded the dug-out, and again we have the evidence of actual remains. Of all the early European races, it is the Vikings who hold the premier position as seafarers, and the influence of the Viking ship was felt for many centuries.

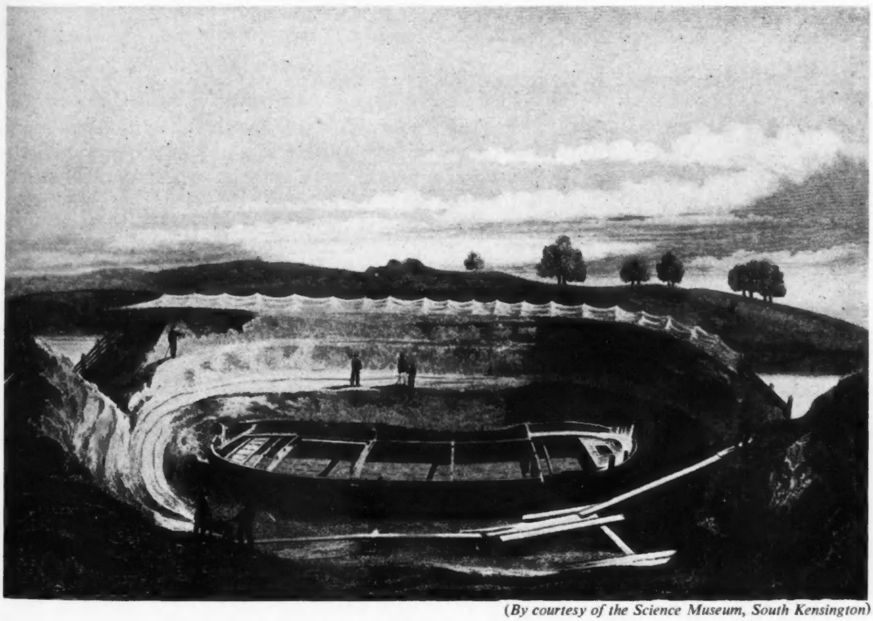
The Vikings were a wild superstitious people, and it was one of their customs that their chieftains, like those of Egypt, should not be separated from their most beautiful and priceless possession—their ship—even in death. Sometimes the body of a lord was placed in his ship, which would then be set on fire and allowed to sail blazing out to sea. This picturesque custom, however, can only be regarded by the nautical archaeologist as a distressing waste of possible data. Another method of burial was responsible for the many remains of Viking ships which have been found in recent times. The dead chieftain was placed in his ship, along with other valued possessions, and a mound of earth of towering height was then raised over the ship and its contents. From these simple tombs the ships have sometimes been recovered, adding one more link to the chain of evidence in the ship's history. One of the earliest of these was found at Nydam in the Duchy of Schleswig. This ship, while not plank-built in the fashion of the later Viking ships, was a step beyond the dug-out stage. When found in 1863, it was singularly free from damage considering its age. System-

atic digging in the marshland under the supervision of the Danish Government was undertaken to obtain the now so-called Nydam ship, and it was afterwards placed in the hands of expert restorers.

The most famous example of a vessel of the later Viking period was found at Gogstad in 1880. The condition of this ship when found was almost perfect, this being attributed to the fact that it was protected from the air by the blue clay in which it was embedded. Another remain was found at Osberg, this vessel being similar in many respects to the Gogstad example. It appeared, however, to have belonged to a woman, this being correlated by the nature of the personal property in it. It was probably a pleasure boat, but was obviously not as seaworthy a vessel as the Gogstad example.

Other less reliable evidence is to be found in the rock carvings, and also in the Sagas. Norsemen and not unnaturally Ships are frequently mentioned in these mythical narrative poems, though such sordid details as dimensions are not given.

After this long era of comparatively detailed and complete information, there comes a time extending up to the end of the sixteenth century when any exact data of the development of ships is scarce. The Middle Ages, in fact, is one of the lacunae during which the nautical archaeologist is stumbling in the dark, with only occasional glimmerings of light to guide him. Details of the ships of William the Conqueror, which differed little from those of the Vikings, are preserved to-day in the Bayeux tapestry. This remarkable piece of needlework, illustrating the life story of King Harold II, is now dated at about A.D. 1120. Being the work of imaginative women with only a limited knowledge of ships, it is not accurate in every respect, although the parts dealing with Harold's shipwreck are clearly worked. After the evidence from the



(By courtesy of the Science Museum, South Kensington)

Vessel of about 1400 A.D. *found near the river Rother in* 1882

(*By courtesy of the Science Museum, South Kensington*)

The earliest known record of sea-going ships. An ancient Egyptian bas-relief in a pyramid tomb

Bayeux tapestry comes an era during which the record of the ship becomes increasingly difficult to trace. It is during this period that the nautical archaeologist is thrown on the tender mercies of the medieval artist, and a more unreliable source of information it would be hard to find. Medieval artists, unlike their earlier brethren of Egypt, had no knowledge of ships, and, moreover, they were drawing for an equally ignorant public. Excessive decoration was the order of the day and there existed a strange kind of conventional picture-language to-day called symbolism.

For the first part of this difficult period, the surviving work of these artists is found on coins and the seals of seaport towns. This in itself would render the task of accurate representation of ships difficult, even if the artists had known anything of them. Artistic satisfaction came before accuracy and the appearance of everything was governed by the space it had to fill. The contortion necessary to fit a picture of a ship on to a circular background accounts for the strange shape medieval vessels were given by contemporary artists. Nevertheless, while general proportion is bad, their crude pictures sometimes give interesting information regarding the rigging and fittings. This is of great value, considering that this blank period occurs when important developments were being made in naval architecture.

The ships represented on coins and seals are either kings' warships, or the large armed ships then owned by the big seaports. They therefore give some idea of the chief ships of their day, but knowledge was still scanty of the smaller vessels engaged in the coasting trade, until an old ship in excellent preservation was found buried in a field near the river Rother in Sussex. This was carefully excavated, and though neither

its identity or date can be placed with any certainty, it is generally considered to be a coasting vessel of about A.D. 1400.

Of the later medieval period, more certain data exists. The powers of artists improved, and with it their knowledge of ships, though much is still left to be desired. Contemporary manuscripts containing pictures of ships appear in some cases to be reasonably accurate, as for example in the Pageant of the Earl of Warwick manuscript, in which the accuracy of the ships shown is vouched for by the correctness of the heraldic devices also illustrated.

It has been shown that the prowess of medieval artists left much to be desired, but there are exceptions to this, the most notable of these being found in a Flemish master who hid his identity under the initials W. A. This unknown artist had a profound knowledge of ships, and the ability to portray them accurately. That his work, even in his own time, was regarded as the doyen of marine artists is shown by the number of contemporary copies that have been found. The wealth of detail embodied in his prints may be judged by the photograph reproduced of a model of a Carrack or merchant ship dated about A.D. 1450. This model was based on the most famous of W. A.'s pictures and is a strict copy of it in every respect. The excellence of the original can be appreciated by the detail in the model. The writer has constructed a smaller scale model of this Carrack, and at this scale it proved necessary to eliminate much from W. A.'s print if the model was not to appear over-burdened with detail.

Nautical archaeology does not end with the Middle Ages—much research has been necessary, for example, to piece together the early history of the steamship. After about A.D. 1500, however, contemporary evidence increases in volume and the subject becomes too unwieldy to be dealt with in a short study.

The Secrets of Camouflage

The principles and the possibilities of camouflage in A.R.P. With a special note on "Dazzle Painting"

THE taxpayer, who is contributing towards the £2,000,000 granted for the purpose of industrial camouflage by the Exchequer, has a right to know what is being done in the direction of camouflaging factories and other important buildings. In official quarters there is a close secrecy about camouflage, and the journalist who sets out to discover something about the present technique will find himself in much the same position as if he were asking about some secret explosive. But as Oliver P. Bernard, a camouflage expert of the Great War, wrote about camouflage at the time of the September crisis: "Secrecy has always been a useful cloak for evasion of duty, opposition to reform in business, in government, among professions and other services essential to national security...."

In his view camouflage sense is common sense, and therefore the technique was not a method to be copyrighted by commercial interests, nor were the principles underlying camouflage to be treated as "official secrets" or worse still as trade secrets. The danger of the present secrecy is that camouflage schemes devised by commercial firms may be inefficient, and that any inefficiency will remain uncorrected in the absence of criticism.

A few words are perhaps necessary to explain why camouflage has a part to play

Harringay Stadium uncamouflaged

in civil defence. To some people it may seem that the bombing plane has reached perfection as a military weapon, and that nothing short of complete evacuation from towns, deep shelters and squadrons of fighter planes (euphemistically called "air defence") can give any degree of protection. This view ignores the one weakness of the bomber—it is not an accurate weapon, except at very low altitudes. It cannot bomb *deliberately* such strategic targets as munition factories with the same degree of accuracy as heavy artillery. Oliver P. Bernard puts it neatly when he says: "A gas holder for example is a conspicuous but not necessarily easy target for bombers *at* 15,000 *ft. plus* 200 *m.p.h.*" When it is remembered that the direction of *deliberate* bombing depends on vision (and not upon mathematics as with heavy artillery) the bomber does not appear so effective as a military weapon, although its destructive effect upon civilian property, life and morale is very great. Against the deliberate bombing of strategic targets such as munition factories, gasometers, cooling towers, etc. every effort should therefore be made to reduce their visibility from the air. By so doing, the accuracy of deliberate bombing could be further reduced. It is noteworthy that the Camps Bill now before Parliament contains a special clause dealing with camouflage of the proposed evacuation camps, while in the case of blast furnaces, etc. efforts are being made to reduce visibility by obscuring the glare and smoke.

The Stadium painted to break up the outline and surface

It should be clear that camouflage is most effective where a building is isolated away from a town. Evacuation camps and aerodromes are ideal subjects for camouflage. In towns, camouflage cannot generally be considered as conferring any appreciable degree of protection on those factories which bad town-planning has allowed to become embedded in the heart of residential areas. The approximate locality of all such factories could easily be recognized from the air by reference to the many landmarks which exist in any town. (As an example, one might quote the administrative centre of Whitehall which is signposted at one end by Trafalgar Square and at the other by Westminster Bridge.) Bombers informed by their secret service of such factories would probably "sow" the whole area as systematically as possible with high explosives, in the hope of registering a direct hit and in the knowledge that even if the factory was missed much damage and many casualties among the civilians would result.

To discover the best method of camouflage, it is first of all essential to realize that the diagnostic features by which a three-dimensional object can be recognized from the air include shape and outline, shadow, colour, reflective value of the surfaces, position. ("Actinic value", the factor which determines the tone of a surface when photographed, is important in military camouflage, where possible objectives such as batteries must be kept secret and where

detection from photographs is possible, but it has little bearing on the question of civilian camouflage.)

All these features can be disguised, obscured or distorted in some way or other. The most effective camouflage technique will be the one which alters as many of these features as possible either to break up outlines, or to make the object merge into its background.

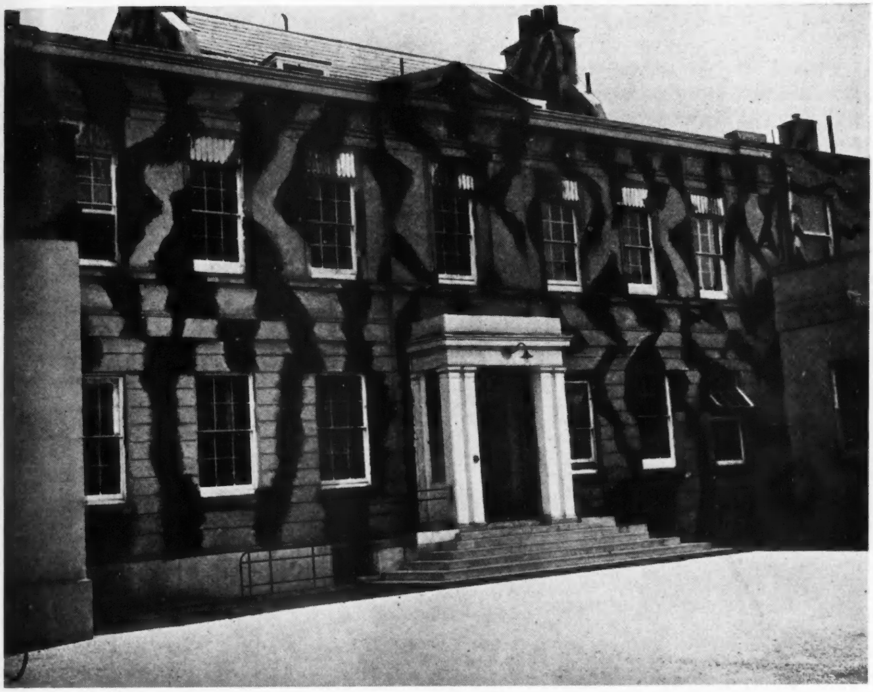
Disguise of shape

The disguise of shape, perhaps the most important of all camouflage principles, is achieved by breaking up the outline and the surface as much as possible by painting. In nature such disruptive colouring is to be found in a great many animals. The zebra is perhaps the most obvious example. Dr H. B. Cott, an authority on colour concealment in nature (vide *The Geographical Magazine*, vol. III, no. 2, June 1936), quotes as notable examples the anaconda, iguana, ringed plover, woodcock, and grass frogs. Of these animals he says, "Distributed over the body are irregular patches of contrasted colours and tones. These patches tend to catch the eye of the observer and to draw his attention away from the underlying form of the animal which exhibits them."

The painted cooling tower at Hackney

The outstanding example of disruptive camouflage in the Great War was the so-called "dazzle painting" of ships. At the outbreak of the War, Britain's battleships were beautifully painted, with cream funnels and black hulls. On the other hand, the German and French ships were painted in sober tones of neutral grey and were certainly less conspicuous. In September 1914, Prof. Graham Kerr, the zoologist, addressed a letter to Winston Churchill, then First Lord of the Admiralty, in which he suggested that battleships might be camouflaged, and suggested natural analogies such as the zebra as a pattern to follow. This letter clearly defined the disruptive principle, and pointed out that it was "essential to break up the regularity of outline, and this can be easily effected by strongly contrasting shades. The same applies to the surface generally; a continuous uniform shade renders an object conspicuous. This also can be counteracted by breaking up the surface by violently contrasting pigments." The data in this letter was communicated to the Fleet in a general order, but "the trial or adoption of the proposals contained therein was left to the discretion of flag officers, etc. concerned."

There can be but small doubt now that the Admiralty should have experimented with models and tested designs on a few selected ships before releasing the idea to the Fleet generally. The principles laid down by Prof. Graham Kerr were, it is true, applied with success on some ships, as the naval architect, Gerard Holmes,



The camouflaged Victoria Hospital at Barnet

revealed in a letter to *The Times* (12 May 1919). "...in spring 1915, four vessels were painted in a manner corresponding to the suggestions contained in his (Prof. Graham Kerr's) letter. This was prior to the submarine menace and the main object was to disguise the outline of the vessels which were the first 4 aircraft carriers to be completed by the Admiralty. I was informed by officers who put to sea with these vessels that the result aimed at was attained and that it was exceedingly difficult to determine the general features of the vessels when they were steaming at sea, and not easy to ascertain their presence."

But, as can be readily understood but not condoned, the Fleet as a whole did not apply these principles of camouflage with any great skill, and their bodged efforts were responsible for leading the Admiralty to conclude that camouflage was impossible. The Admiralty forthwith gave orders that the Fleet was to be painted in neutral monotone. The view of the Admiralty experts towards camouflage at that time can be judged from the wording of a caption to a press photograph released later. "A very early type of camouflage. This was done under the influence of professors, *and depended for its effect upon colour contrasts. However, at sea colours deteriorate very rapidly and such camouflage becomes ineffective*." The truth of the principle italicized was clearly shown two years later when it was reintroduced under the name of "dazzle painting". (The other comment, about deterioration, was superfluous, and obviously applied to any

method of camouflage by paint, the very medium which was used in "dazzle painting"!)

By 1917 the submarine menace made it essential that every trick should be used to defeat it, and in that year "dazzle painting" was introduced. Its sponsor, Lt.-Commander Norman Wilkinson, the artist, had a very clear conception of the difficulties of camouflaging ships, and met those difficulties more scientifically than did the Admiralty experts at the earlier attempt. In his published lecture on "The dazzle painting of ships" (read before the North East Coast Institution of Engineers and Shipbuilders, 10 July 1919) he gave an excellent account of the method of testing designs, which established the scale model as the soundest method of testing out camouflage schemes generally. All his naval camouflage patterns, depending upon the disruptive effect of stripes and

Design Unit, Ltd.

The camouflage treatment worked out for the well-known Gillette factory on the Great West Road. The photograph above shows that there is a clock tower, a smoke stack and a water tower. These cast long shadows and are very difficult to camouflage, so that the designers have left the smoke stack and the small buildings and the water tower uncamouflaged to give the impression that this is a small affair and not worth bombing. This photograph shows the factory as it would appear from about 500 ft.

On the right of the photograph, a projection which sticks up above the main elevation of the factory has been given a false roof to look like a farm building. The formalized shapes supported on cables look from a great height like trees. The sloping sides to the factory are formed by letting down netting over cables and suitably painting the netting to give the effect of roads, etc. By sloping the factory walls in this way the factory does not throw shadows unless the sun is very low in the sky

blotches of different colour, were devised, using small wooden models of the ships to be painted. The designs were applied in water colours so that they could be altered conveniently. Each model was carefully studied on a prepared theatre through a submarine periscope, various sky backgrounds being placed behind alternately. The most satisfactory pattern was then reproduced on paper, and this plan, showing both port and starboard sides, was forwarded to the officer in charge of painting the ship.

The efficiency of the scheme was further tested at sea, captains being asked to report to the Admiralty on the appearance of all scheduled camouflaged vessels. There can be no doubt that the *actual* and *apparent* course differed sufficiently to confuse submarine commanders when directing a torpedo attack. Wilkinson's own explanation is as follows: "If the accepted form of a vessel could be so completely broken up by contrasting colours and tones of paint as to destroy her outline and general shape, a large point would have been gained towards increasing the difficulties of attack." It must be admitted that such camouflage had the added advantage that irregular light reflection from waves would increase the confusion, which may justify to some extent the use of the mystical term, "dazzle painting".

The same method of disruptive colouring was applied to the masking of guns which were painted in blotches of brown, green and cream: to avoid blending of these colours as seen from a distance, they were separated by a band of black paint.

For civilian camouflage this scheme has great possibilities. A cooling tower camouflaged on these lines to a design by Oliver P. Bernard is illustrated here. The contrasted colours of such a scheme must be applied in large blotches, otherwise they will blend to produce a monotone surface when seen from a great height. Such a surface with but feeble disruptive patterns will be visible from the air. Bernard also suggested

Design Unit, Ltd.

The Gillette factory as it might appear from 2000 feet, but designers work so that the camouflage will be 100% effective at 15,000 feet—below which bombers would probably not fly on account of anti-aircraft fire and the balloon barrage

the possibility of building structures so that shadows, etc. might be eliminated, and although no examples of such "architectural camouflage" are yet available, it is well known that shadow, a tell-tale feature which must always be considered can be reduced to the minimum by applying the truncated pyramid principle as suggested first in England by Solomon J. Solomon, perhaps the greatest camouflage expert the Allies had.

Disguise of shadow

Where special buildings such as evacuation camps and aerodromes are being built for war service, shadow can be reduced to a minimum by the design. In the case of aeroplane hangars, for instance, a modification of the truncated pyramid principle is used. Generally it is essential to falsify the shadows as well as the outline, and this can be done by adding masks as superstructures to a building so that they throw an irregular shadow on the ground.

The importance of shadow cannot be too strongly stressed, and if an evacuation camp in open country were camouflaged to match the surrounding countryside it would be essential that the rectilinear shadow cast should be masked in some way. This might be done by adding superstructures, or by faking shadows on the ground. For instance, in the Great War, it was possible to counteract the effect of shadow by removing the turf upon which the predominant shadow fell. (Aerial observation in those days was restricted rather conveniently to almost fixed hours and the position of shadows at that time of day could be readily calculated!) By removing the turf, the soil underneath was disclosed and this was generally of a lighter colour (as seen in a photograph) than the surrounding grassland. The light colour of the ground on which the shadow fell compensated for the shadow. (The principle of this "compensative shading" was first described by the American artist and naturalist, Abbott H. Thayer, who designed the famous disappearing ducks to be seen in the Science Museum.)

Disguise of colour

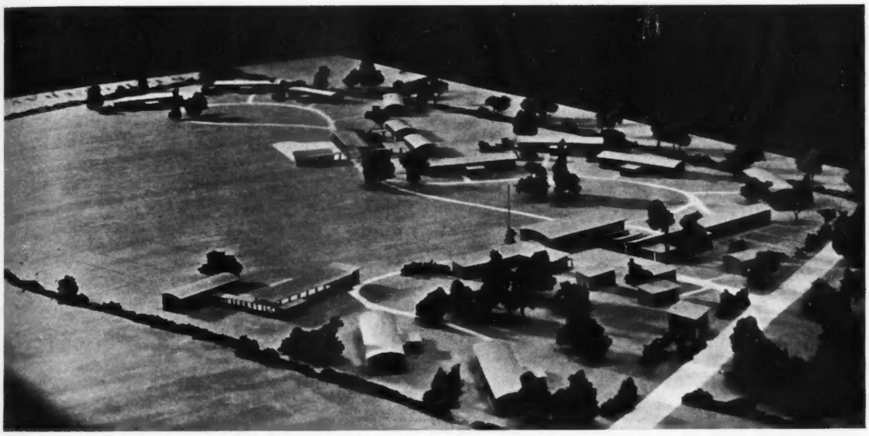
Colour matching is the simplest form of camouflage and is analogous to "protective colouring" in nature. Its application to civilian camouflage is probably restricted to isolated buildings in the open country. Views about "protective colouring" have changed considerably in the past few years and it is now realized that almost invariably this form of colouring (to make an object merge into its background of similar colour) is coupled with some form of disruptive marking and also compensative shading. This is true of all except a few small animals such as the leaf and stick insects which, because of their natural mimicry as to shape, are rendered invisible against their background by simple colouring.

It may be laid down now that wherever possible the shape of a building should be distorted by the application of the disruptive principle. The colours used for this colour contrast effect should presumably fall within a range of *natural* colours (vivid reds presumably have no use). It is to ensure that a natural range of colours is used that the Home Office recently approved a list of standard colours, but these standardized colours are almost too restricted in their colour range.

Reflection value

When paint is applied for camouflage purposes it is generally best that it have a similar reflection value to that of the surroundings in which the camouflaged building is situated. For this reason a matt surface is preferable to a shiny one, and flat drying paints are being used. A great deal of attention is also given to the texture of the surface, although there is abundant evidence to show that this is only important in so far as it reduces the reflexion value. It is perhaps an atavism dating back to the time when hay and sand were sprinkled over the wet paint to reduce reflexion *while the paint was still wet*.

Actinic value has received a great deal of notice in the publications of various commercial camouflage firms, but it is debatable whether it is as important as they think. Actinic value was a primary consideration in the *detection* of camouflage schemes for military reasons. But with civilian camouflage, there is little likelihood that the enemy will rely on photographic observation in time of war to detect camouflaged factories.



This model of an evacuation camp illustrates an arrangement of small dispersed buildings to which camouflage, as "protective colouring", could be applied. The design, by Richard Sheppard, A.R.I.B.A., and Jean Shufflebotham, A.R.I.B.A., won the first prize of the Building Centre competition for camp designs.

The use of photographs, and hence the interest in actinic values, has been in designing camouflage schemes. But a camouflage scheme devised by applying colours to a matt print of a photograph is not as sound as the use of models. Where perfection is required, aerial photographs may be a good test of a finished camouflage scheme.

In conclusion, it may be mentioned that there is a Government camouflage department to which all three fighting services as well as the A.R.P. department of the Home Office can refer. But what is necessary to-day is that this department, augmented by artists and scientists, should develop a national policy for camouflage, so that the most efficient schemes can be designed as cheaply as possible.

The old official distaste of camouflage is breaking down. The camouflage experts of the Great War with their slogan "Indifference to concealment is the disease of gallantry", which so annoyed G.H.Q., would be pleased to see that their efforts were not in vain. The army now has netting and canvas streamers to conceal big guns; the British planes are camouflaged (for use in daytime; the present camouflage makes them actually more conspicuous at night) and the French tanks are camouflaged before they leave the factories. In A.R.P. we are still at the stage where "indifference to concealment" is considered a virtue, owing to the absence of adequate shelter accommodation. That indifference must not be allowed to interfere with the efficient camouflage of vital buildings.

W. E. DICK.

Notes of the Month

"KNOCK-FREE" FUELS

It has been estimated that approximately two-thirds of the mechanical horse-power of the U.S.A. is developed by internal combustion motors of the spark ignition type. In such Otto engines a mixture of fuel and air is admitted to the cylinder, compressed by the upward movement of the piston and then ignited by the spark. The liberation of heat during the subsequent combustion causes a rapid rise of pressure, and the expanding hot gases force the piston down in its "work stroke". The thermal efficiency (that fraction of the heat liberated by combustion, which does useful work) and the power of the engine are both increased by increasing the ratio of the pressure of the unburnt charge at the end and the beginning of the compression stroke. Since fuels tend to "knock" with increasing compression, an upper limit is placed on the power and efficiency of the engine. Post-war research has shown that this "knock" is the explosive combustion of the unburnt charge ahead of the flame front of the fuel which is burning normally. Great power loss, overheating and mechanical strain of the engine result from such detonation, the elimination of which is therefore of the first importance. Partial reduction in the tendency to knock may be obtained by spark retard and improved cylinder design, but the greatest advances have been in the reduction of the knocking tendencies of the fuels themselves.

To understand how the latter is accomplished two features of the oxidation of hydrocarbons must be borne in mind. First, that given fuel-air mixtures only react explosively above a certain minimum pressure; and secondly, that these combustions are extremely susceptible to catalysis by traces of foreign substances, which manifests itself in a lowering of the minimum temperatures and pressures necessary for spontaneous explosion. Peroxides are particularly effective as catalysts, and it is an interesting fact that alkyl peroxides have been found in the knocking part of the charge prior to inflammation and that, generally speaking, the knocking tendency of a paraffin increases with its ability to form a peroxide and also with molecular weight. The method in most common use for reducing knocking tendencies is the addition to the fuel of an "anti-knock", such as tetra-ethyl lead, $Pb(C_2H_5)_4$, which, it is thought, destroys any peroxide substances which may be formed in the charge, and so prevents the detonation characteristic of knock. In the last few years, however, attention has been directed to methane, CH_4, as a possible knock-free fuel, since it is the paraffin of least molecular weight. A small single-cylinder internal combustion engine running on methane has recently been demonstrated, which was completely free from "knock" even at high compression ratios. In view of the large potential sources of the gas, its high anti-knock properties and high calorific value per unit volume of the liquid, it would not be surprising if in a few years petrol stations were replaced by depots where empty liquid methane containers could be exchanged for full ones. F. S. D.

(*Egerton and collaborators: Oxford and London*)

OIL IN ENGLAND

THE search for oil in England achieved its most successful result recently at Eakring, near Nottingham. The bore which had been put down by the D'Arcy Exploration Co., a subsidiary of the Anglo-Iranian Oil Company, struck oil at 1914 ft. By the beginning

of July 100 tons of oil had been drawn up, and it is expected that approximately this amount will be produced each week.

Prospecting for oil is done under licence from the Board of Trade in accordance with the Petroleum (Production) Act of 1934. Since that time 98 licences have been issued, and 77 of these covering an area of 11,800 square miles are in force. Sixteen deep bores have been made.

Oil and natural gas have been met with in a bore near Edinburgh, natural gas near Whitby. The oil strike at Eakring is the richest yet made; smaller quantities of oil at a shallower depth were found to occur at Formby near Lancaster.

The search for oil in England dates back to the days of the Great War, when the submarine blockade menaced our petrol supplies. It was Admiral Fisher with Sir Henri Deterding who first expressed the view that petrol supply might be a controlling factor in war time. Since then, of course, petrol has become all important to modern transport, and though totalitarian "self sufficiency" was not intended, the quest for oil in this country has become more urgent.

At the end of the Great War prospecting was started in the Chesterfield (Derby) area, and oil was struck at one bore at Hardstoft at 3077 ft. in May 1919. This well has been yielding continuously ever since, although the initial yield of ten to eleven barrels a day fell off after a few years to about seven barrels.

W. E. D.

Science News Service

GASES FOR RIPENING FRUIT

An interesting phenomenon connected with the ripening of fruit is the stimulating effect of the gas ethylene, which is finding wide commercial application. This was discovered some thirty years ago when the lemon growers of California wondered precisely what were the factors controlling the ripening of lemons. At that time it was customary for them to pick the lemons from the trees when they had reached a certain size and at that stage there were always some green lemons among the fruit, which were temporarily unsaleable. These green fruits were sorted from the rest, and packed into tents which were heated artificially. In 1912 it was realized that it was not only the heat, but rather the gases produced by the heating stoves, which caused ripening. The exhaust from an old Ford car had the same ripening effect! It was later discovered that the particular gas responsible was ethylene. To-day the green lemons are ripened during transport, small quantities of ethylene gas being added to the atmosphere of the storage rail cars from cylinders of the gas.

Ethylene has a ripening effect on bananas, peaches, pears and apples. It does not, however, appear to have any appreciable effect on grapes or oranges.

The ripening method now practised in Australia for ripening bananas now includes this "ethylene stimulation". Ethylene is supplied for about 2 days while the bananas are kept in a store at a temperature of from 66 to 69° F. Then after 4–5 days at this temperature but in an atmosphere free from ethylene, the fruit reaches the one-half to three-quarter ripe stage, when it is ready for distribution to retailers.

Acetylene gas has the same effect, causing the ripening of tomatoes, oranges, bananas, peaches and plums. For instance, in an atmosphere containing 1 % of acetylene at a temperature of 65° F. green Kelsey plums ripen completely in 5 days. Tomatoes under these conditions ripen 10 days before their normal time, and the ripening of bananas is also accelerated appreciably. Fruits treated with acetylene begin to show a healthy tint within 24 hr., and are said to be sweeter

than fruits allowed to ripen in the ordinary way.

In the laboratory which deals with the fruit problems of Covent Garden the effect of acetylene has been tested on Kelsey plums. Samples were exposed to an atmosphere containing 2% of acetylene for 5–6 days at 65° F. After that time they had developed an orange colour. They were then removed and kept at ordinary market temperature, in the absence of acetylene, and after a further period of 8–10 days they were ripe for distribution. W. E. D.

Science News Service

THE RADIO TYPEWRITER

THIS radio typewriter operates over long distances and is notable for its simplicity. It can be operated by any stenographer, as no particular technical knowledge is required. The letters or messages are typed on a standard typewriter keyboard and are simultaneously printed on a paper tape at the receiving end, where no operator is required. In the interior of the sending machine there is a revolving cylinder composed of disks, there being a separate disk for each letter of the alphabet and the other characters on the typewriter keyboard. If the letter *k* is tapped on the keyboard, a circuit is closed on the disk *k* and the impulse *k* is then sent out on the air. The impulse *k* is picked up by the receiving machine and, after being amplified, it actuates a magnet that causes the moving paper tape to be pressed against the letter *k* on a rotating alphabet roll. Little trouble is had with static, and the messages can be sent as fast as the typewriter can be operated.

P. C. HOLAHAN.

(*Chicago*)

SCIENTIFIC LIMIT FOR MOTOR HORNS

METHODS developed in the Sound Division of the National Physical Laboratory for measuring and controlling noise have found a welcome application in the new limit, which will come into force in October this year, for restricting the noise of motor horns. By agreement between the Ministry of Transport and the motor trade no horns

"with a loudness exceeding 100 phons" will be fitted to motor vehicles after 1 October.

The investigation into the noise of motor horns was undertaken by the National Physical Laboratory for the Ministry of Transport. The object of this investigation was to correlate the stridency of horns with some special characteristic which could be measured scientifically. As a result of this work the Departmental Committee concerned recommended that the noise of a motor horn should not exceed 100 phons at a distance of 20 ft.

In a comparative scale of noises, an aero engine is between 110 and 120 phons, a pneumatic drill 105–110, the interior of a tube train 90–95, loud conversation 60–75, while the sounds of a quiet country house are but 20–30 phons.

It is interesting to note that, according to last year's report, the National Physical Laboratory is carrying out research for the Institution of Automobile Engineers into the more efficient silencing of motor cycles, and the reduction of the drumming of motor-car panels. Measurements are also being made for the London Passenger Transport Board to assist in the lessening of the noise in tube trains. W. E. D.

(*Science News Service*)

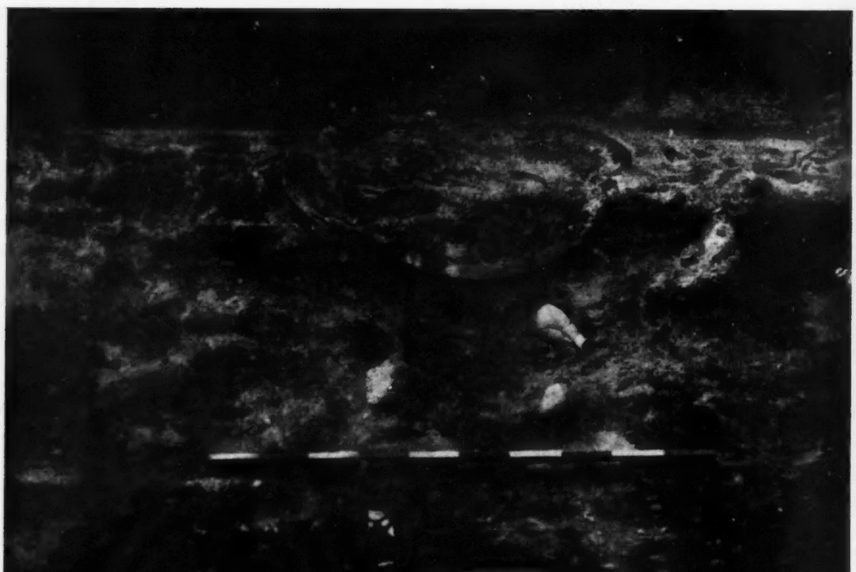
A SAXON SHIP BURIAL IN EAST ANGLIA

RECENT excavations at Sutton Hoo, near Ipswich, carried on by Mr Philip Brown under the direction of Mr Guy Maynard, curator of the Ipswich Museum, have resulted in an archaeological discovery of major importance. The find consists of a ship, constructed of long planks fastened by iron rivets, containing a large collection of gold ornaments, silver vessels and other objects. The vessel, which was buried in a tumulus on high ground overlooking the River Deben, constitutes the burial place of some Saxon leader of about A.D. 600. With the exception of traces of a smaller vessel uncovered on Snape Common, two miles away, in the 'sixties, no ship burial has previously been found in Britain, although these are fairly common in northern Europe, reaching their highest stage of development in Scandinavia in the time of the Vikings. The practice of ship burial is connected with beliefs in a voyage after death to a spirit world over the water, and equipment and treasure of various kinds was placed with the body for use in the next world.

The Sutton Hoo ship compares favourably in size with continental specimens, being 82 ft. long, with a beam of about 16 ft. Little trace of the wooden structure remains, but the shape of the ribs can be detected, and the rows of iron rivets indicate the size and outlines of the vessel. The ornaments and other objects were found on the floor in the centre of the ship, partly covered by rotted timber and sand, which appear to be the remains of a wooden platform, now collapsed, built to receive them.

The nature of the hoard indicates that the owner was a warrior and leader of the highest rank. Among the finds are fragments of a full equipment of arms, including an iron sword, of which the pummel and handgrip, ornamented with gold and garnet cloisonné and gold filigree remain, an iron helmet with bronze facepiece, and a wooden shield, now decayed, with bronze mounts and a bronze boss with an enamelled stud. There is also a suit of decorated chain mail and a miscellaneous collection of iron spears. The presence of a ceremonial hone-stone, or weapon sharpener, with four bearded heads carved at each end, and probably intended as a symbol of rank rather than for use, is held to support the theory that the owner was a person of unusual importance. Various other buckles, studs, and plaques, of gold with fine quality

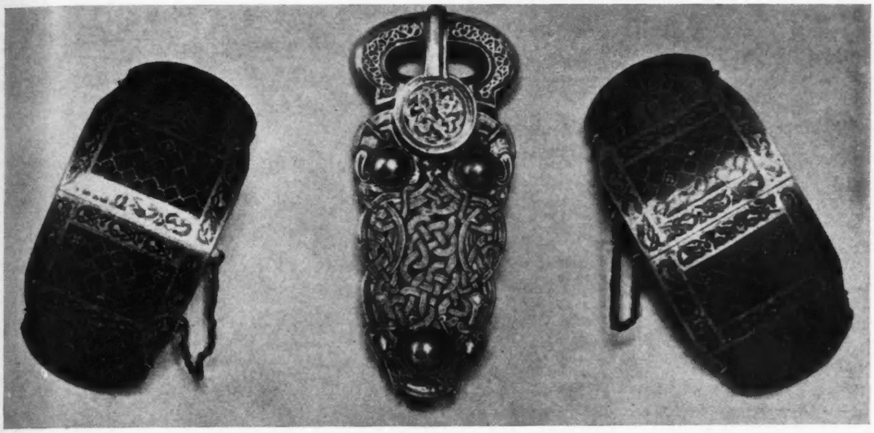
General view of the ship-burial at Sutton Hoo, just before exposure of the funeral hoard. The outlines of the boat and traces of the ribs are clearly visible. The large silver dish can be detected to the right of the small measuring rod beyond the plank in the foreground.



Guy Maynard

Close-up of the large silver dish in situ.

Some of t



Some of the objects, after cleaning, discovered at Sutton Hoo. The photographs show clearly the wonderful state of preservation of the articles

cloisonné work, evidently belonged to the sword sheath and an elaborate belt, now perished. Inside the remains of a purse made on a frame of gold and garnet cloisonné, two small gold ingots and forty gold coins of the Merovingian Franks were found. These are crude copies of Byzantine coins of various reigns, which enable the find to be dated approximately to A.D. 600. The style of the cloisonné ornaments in general suggests closer association with continental Frankish culture than with that of the Kentish settlements of early Anglo-Saxon date.

Placed near the burial was a large bronze bowl of Egyptian workmanship, containing a smaller bronze hanging bowl decorated with scrolls and escutcheons of millefiore work. Nine shallow silver bowls, obviously a table service, were found inverted one inside the other in the grave. Under the bowls were two silver spoons, and the remains of nine silver mounted drinking horns were found in another part of the grave. In the middle of the burial chamber was placed one of the most striking finds of all, a great silver dish, some 3 ft. in diameter, beneath it was a smaller silver dish containing various wooden bottles and bronze and silver bowls. The large silver dish is in an excellent state; it is considered to have been made in Constantinople about the year A.D. 520. The hoard is completed by remnants of decayed cloth, linen and leather, three large bronze cauldrons, three wooden buckets, and some iron chain work.

While there is as yet no means of establishing with certainty the original owner of these finds, it is considered highly probable that they mark the burial place of Redwald, ruler of the East Angles, who died about the year A.D. 627. The character of the finds points to a date about the first quarter of the seventh century: their richness and quantity suggest a person of outstanding importance, and Redwald's name is particularly associated with this part of East Anglia; for example, his capital is believed to have been at Rendlesham, four miles from Sutton Hoo, on the north bank of the Deben, and appropriately "across the water".

Whether the Sutton ship burial is that of Redwald or of some other of the rulers of Saxon East Anglia, its discovery is an event of great importance in British archaeology, and the detailed examination of the finds, which are now in the hands of British Museum experts, is expected to provide valuable new evidence for the study of the Saxon occupation of East Anglia. Mr C. W. Phillips, F.S.A., is now in charge of the excavation, which is being completed under the auspices of the Office of Works.

C. F. E.

(*Below is a note on ship burials in general, by E. N. Fallaize, who contributes regular archaeological notes to* Discovery. *An article on Early Ships by D. H. Birt appears on page* 461.)

ALTHOUGH reference is made in the Norse sagas to the Viking custom of disposing of the body of a dead chieftain by placing it in his ship or rowing galley, the number of such burials which have been found is small; and in view of the value of these great rowing vessels the custom was probably followed in actual practice only in the instance of chiefs of great fame or importance. Of the ship burials which have been discovered the most striking and best known are those of the Gokstad ship and the Osberg ship. The Gokstad ship, which was found in a mound near Sandefjord in Southern Norway in 1880, is a small war vessel of 78 ft. long, pointed at both ends, and fitted for a mast and sixteen pairs of oars. A row of shields had hung over the outer side of the bulwarks, thirty-two on each side, so that the vessel must have carried a complement of at least sixty-four men, although it has been computed that

the average crew of a Viking galley numbered from forty-eight to fifty men. The body of the Gokstad chieftain lay in a grave chamber behind the mast, and with the body, in addition to the arms and personal equipment, were the remains of twelve horses, six dogs and a peacock.

The more recently discovered ship burial at Osberg was of a far more imposing character, and from its contents is judged to be the burial place of a queen. The grave furniture consisted of a complete outfit to meet personal requirements, and included the queen's bed, sledges, vessels and ornaments.

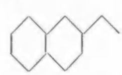
As these vessels were pointed at both ends with raised prow and stern, and steered with an oar fastened on the starboard side, they were peculiarly well suited to manœuvring in the narrow waters of the Norwegian bays and fjords. A vessel constructed on the model of the Gokstad ship, and of the same size, proved eminently seaworthy, and successfully crossed the Atlantic for the Chicago Exhibition of 1893.

CHEMICAL BASIS OF SEX APPEAL IN SEA URCHIN EGGS

In the August number of *Discovery* Dr Nowinski explained the extraordinary way in which the sex of *Bonellia* is determined, but there are many other problems on the sexual life of the small sea animals yet to be investigated. Recently, owing to the work of Kuhn, Wallenfels, Hartman and Scharter, at least one problem has been elucidated.

In the case of *Bonellia*, the male lives in the vicinity of the female sexual organ, and so the chance of one kind of cell finding the other is very great. But how does it come about that the spermatozoa and the eggs of, say, the sea urchin ever come into contact? The adults of both sexes excrete the tiny cells and leave it to them to encounter their partners in the huge ocean. The number of sexual cells yielded by a single adult of either sex is very great, so that even if only a small proportion of the reproductive cells succeeds in finding sexual counterpart, propagation will go on, and the continuity of the species be secured. Nevertheless, it is amazing that even a few of the spermatozoa should find an egg to fertilize. It contradicts the law of chance and runs counter to all statistical expectations.

The Chicago zoologist F. R. Lillie and other investigators have shown that the mature eggs of the sea urchin excrete substances into the sea water which allure and agglutinate the spermatozoa. Recently a red pigment has been isolated from sea urchin eggs: it is called "Echinochrom". Investigation shows that this pigment is the factor which causes the spermatozoa to travel from a distance in order to come into contact with an egg. The agglutinating substance is only produced by mature eggs. "Echinochrom" has, however, been found to be present in cells not yet completely developed; thus an immature egg ensures that there will be enough male elements to be made use of. "Echinochrom" has a comparatively simple chemical structure: two combined benzol rings and a side chain are the skeleton.



The melting point is at 220° C. The limit of its physiological activity is 1:2,000,000,000. Thus one part in two thousand million parts of water will be sufficient to signal the presence of an egg to the spermatozoon. H. L.

Lederer, Paris; Kuhn, Heidelberg; Hartman, and Schartan, Naples.

The Cloud Chamber

By A. K. Solomon

(How is it possible to photograph the tracks of a split atom? In this article Dr Solomon, who wrote in the July issue about the Cyclotron, gives us an equally clear and interesting account of another instrument of the greatest importance in the rapid modern development of nuclear physics.)

THE story of the cloud chamber is the story of a Scotsman and a mist. Walking one day through a typical Scotch mist the Scotsman stopped to notice the lovely colouring of the sunlight seen through the mist. Being of an inquisitive mind, he wondered what caused the various colours. And there began the path that took C. T. R. Wilson to the Jacksonian professorship at Cambridge. All that is legend.

But the cloud chamber itself is not legend. It is, in fact, one of the most powerful tools available to nuclear physicists to-day. The cloud chamber enables the physicist to take pictures of the atoms he splits, or, more precisely, to take pictures of where the atom has been, the tracks that the split fragments leave behind them. Thus the scientist has direct visual evidence of the track of an atomic projectile hitting another atom and the tracks of the fragments after the collision. From this data and the fundamental laws of mechanics he is able to calculate the energy transferred in nuclear collisions.This in turn gives valuable information about the nuclei concerned.

These modern applications were far from the mind of C. T. R. Wilson as he stood that day in Scotland. But none the less, even now, forty-two years after the publication of his first paper on the subject, there has been no fundamental change in the design of cloud chambers for which Wilson was not responsible. In the main the story of the cloud chamber is the story of one man.

For Wilson the first step in the study of mists was the artificial formation of mists. The method which he adopted for the formation of his clouds and the method still in use to-day is the sudden expansion of a gas saturated with vapour. At a given temperature a gas such as air in contact with a sufficient amount of vapour such as water vapour becomes saturated with the vapour. Such a condition can be found in a half-filled water tumbler. The amount of vapour which is necessary to saturate a gas is dependent on the temperature of the system. In general as the temperature becomes higher the amount of vapour necessary to saturate the gas becomes greater. If then, in a saturated gas-vapour system, the temperature is suddenly lowered there will be more vapour present than necessary and a condition called supersaturation will ensue. Depending on the degree of supersaturation the vapour will remain in the gas or else will condense in the form of raindrops or fog and remove itself from the gas.

The most important method of cooling is the expansion of gases. This, in fact, is the method used to cool all mechanical refrigerators. Consequently, in order to form a mist, it would seem best to saturate air with water vapour, cool it by sudden expansion, and so secure the necessary mist. For Wilson's experiments the easiest and neatest method of cooling was to expand the saturated vapour itself.

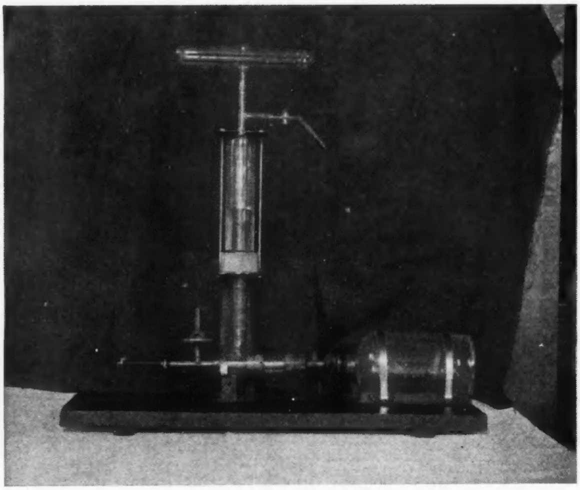
In his earliest work the Scotsman did indeed investigate the colour of the mists. He found that under certain conditions of expansion he secured heavy mists, and he found that the colours he saw by looking at light through these mists depended on the degree of expansion, that is, on the degree of supersaturation. But far more interesting than the colours themselves was the ques-

tion of the mists and the conditions of expansion under which a mist was just possible, and finally the borderline between mists and rains. There were, in fact, some expansions which would produce neither rain nor mist if the gases involved were clean. At this early period of uncertainty great care had to be taken to keep the apparatus clean and dust free. For this purpose most of it was made from glass.

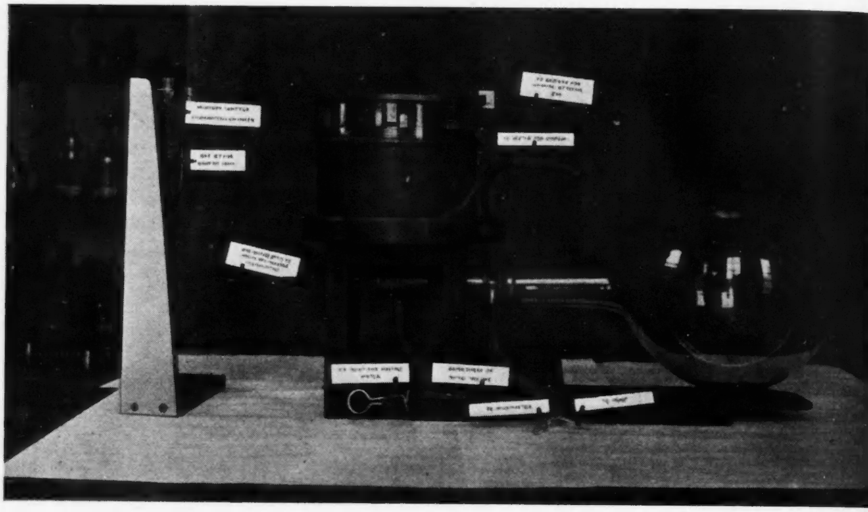
A proper understanding of a cloud chamber requires an understanding of the term "expansion ratio". The expansion ratio is the ratio of the volume of the expanded gas to its volume just before the expansion. Thus if 10 c.c. of gas is expanded to 20 c.c., the expansion ratio is 2·0; if expanded to only 12 c.c., the expansion ratio is 1·2, and so on. In his early work Wilson found that there were critical values of this expansion ratio. Thus, for expansion ratios of 1·25 or less, there was no condensation at all in clean air. With ratios slightly higher than this the condensation was in the form of a rain of droplets. But when the expansion ratio was greater than 1·38 the rain abruptly became a heavy fog. It was in these heavy fogs that the colouring was investigated.

In 1895, just two years before the publication of Wilson's first paper, Röntgen had discovered the rays that bear his name, or more commonly are called X-rays. Wilson decided to see if the fogs were influenced by these rays. In the region of the rains, that is between the expansion ratios of 1·25 and 1·38, he found that the presence of X-rays considerably increased the number of droplets formed. In his next article in 1899 Wilson investigated the effect of the newly-discovered radioactive element uranium. The rays from uranium produced the same effect as the X-rays. By this time he was convinced that the centres for the rain-like condensation were charged particles, or ions formed by the passage of the X-rays or the uranium rays through the air.

By 1912, Wilson had designed the cloud chamber pictured on p. 486, the prototype of all modern cloud chambers. The diagram below it illustrates the mechanism. *A* is the cylindrical expansion chamber proper, 1 ft. in diameter, with walls and roof of glass so that the clouds may be visible. Directly below *A* is the piston whose abrupt descent alters the volume of gas in *A* and brings about the required expansion. The system of piston and cylinder is very much the same as that in an automobile engine, with the exceptions that the piston is not propelled by an explosion, and that the cylinder walls are transparent. The bottom of the piston is immersed in an inch or so of water which not only seals the piston, as does the oil in an automobile cylinder, but also provides the necessary water for the saturation of the gas enclosed in *A*. It should be mentioned that the expansion must be instantaneous to provide ample cooling. Immediately after the expansion the gas in the chamber heats up, due largely to conduction of heat into the gas from the walls of



An 1899 *model cloud chamber*



The cloud chamber as improved in 1912

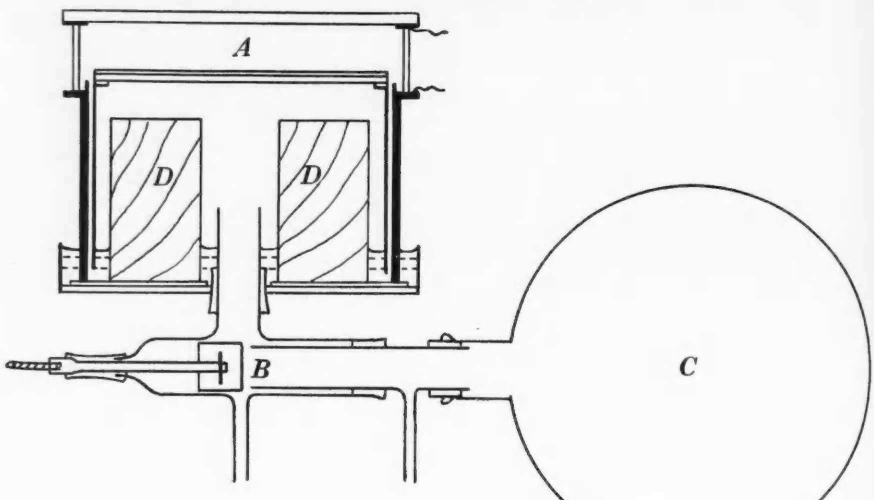


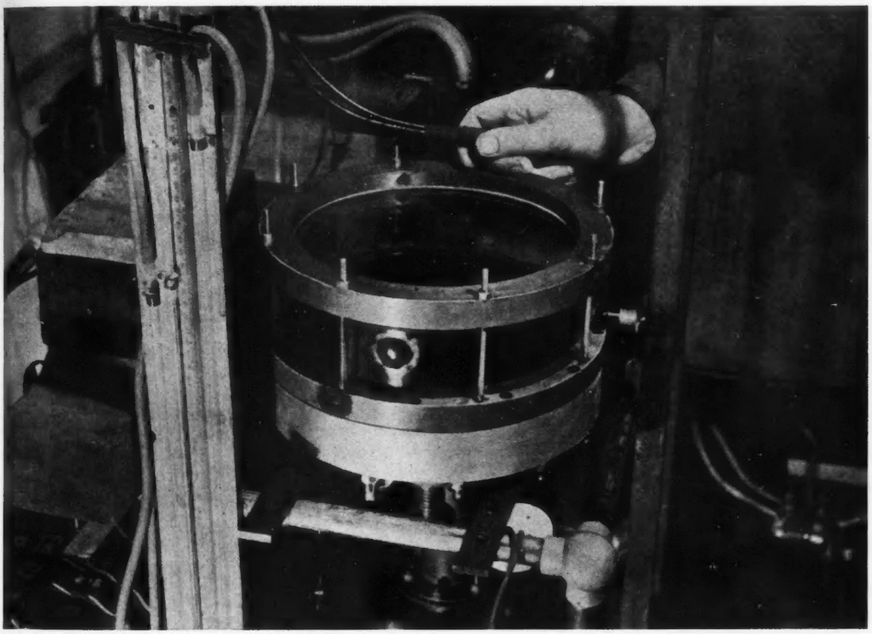
Diagram of a 1912 *model*

the cloud chamber. If the expansion is slow, the gas will have begun to heat up during the expansion. Wilson secured his sudden expansion by the instantaneous removal of all the air below the piston. With no air to support it the piston drops like a shot bird, pushed faster by the pressure of air in the chamber *A* above it. To remove the air

suddenly, the space below the piston is connected by wide tubing to the flask *C*. The entrance to the flask is closed by a rubber stopper *B*, and can be opened by a sharp pull on a rod connected to *B* from the outside. To operate the chamber, all the air is pumped out of *C*, and the valve *B* opened to its full extent. The air then rushes out of the space below the piston into the empty flask and the piston descends instantaneously. The wooden blocks *D* are put below the piston to reduce the amount of air that must flow into the flask *C*.

Wilson found that the drops in the rain-like expansion form on ions. Dust particles also cause the formation of droplets—in fact this is largely the case in an ordinary rain storm—but once the chamber has been cleaned of dust, the centres that remain for the formation of droplets are charged particles or ions. It is this feature which makes the chamber so important in nuclear physics. Each ion serves for the formation of one droplet. Counting the number of droplets gives the number of ions formed.

One of the products of natural radioactive disintegration is the alpha particle, a helium atom stripped of its two external electrons. The alpha particle has a charge of two units due to the loss of its electrons and a weight closely equal to that of a normal helium atom. In some cases, such as the natural disintegration of thorium C, the alpha particle is emitted with an energy of 14 million volts. Such high energy shows that the particle is travelling initially at a speed of 45 million miles an hour. In air the alpha particle rapidly loses its energy by giving it up to the molecules near which it passes. These molecules it ionizes—the separation of the uncharged molecule into two parts charged equally and oppositely is

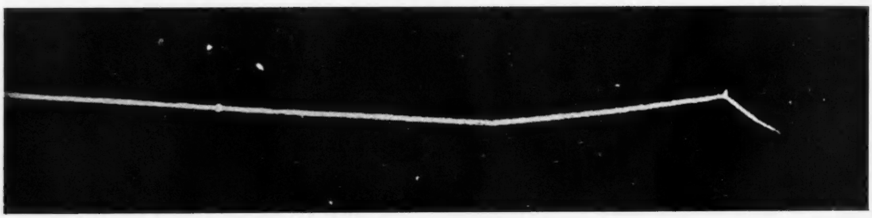


A modern cloud chamber

called ionization. Every molecule ionized causes the formation of one ion pair, consisting of a positively charged and a negatively charged body. The formation of these ion pairs by the alpha particle is so intense that the particle travelling originally with a velocity of 45 million miles an hour is brought to a complete stop in 3·3 in.

An alpha particle fired into a cloud chamber immediately after the expansion would cause condensation of droplets on all the ions left in its wake, leaving as mark of its passage a narrow trail of closely clustered droplets.

To make the droplets visible, or as in the case above, the track visible, light from a strong mercury arc lamp is sent through the chamber, and the bottom of the chamber painted black to provide contrast for the white track. A permanent record of the track is provided by setting a camera above the cloud chamber and photographing the track at the proper moment. The figure above is an example of such a photograph of a single alpha-particle track. The phrase, "the proper moment", hides a great many of the difficulties of cloud-chamber technique. Since the chamber heats up so quickly, in about 1/50th of a second, the observations must be completed before the chamber has become so warm that the drops disappear. This is but the first difficulty. The next is caused by the presence of any stray radiation that may be nearby. Any radiation which passes through the chamber and causes ionization during the expansion will leave tracks made up of very small droplets. Such stray tracks must be removed. An electric field of a few volts between the top glass plate of the cloud chamber and the top of the piston will remove the effects of these rays. All the droplets, being formed on ions, are charged, and the electric field attracts these charged droplets. Consequently some, say the negatively charged ions, will rise to the top of the chamber, and the others, the positively charged ones, will sink to the bottom. Here they condense on the walls and no longer interfere with other tracks. Since the tracks are formed equally of positively and negatively charged particles, the effect of the electric field is first a broadening of the track, and then finally a separation of the ions into two groups, one negative, rising towards the top of the chamber, the other, positive, sinking towards the bottom of the chamber. Once the expansion is complete, the drops form very quickly on the ions. These large drops are so heavy that they move very slowly in the electric field, so slowly in fact, that they appear still. This places another limitation on "the proper moment", for the alpha ray must be shot into the chamber immediately after the expansion so that the track has no chance to disperse. To perform all the operations in the proper sequence a delicate timing mechanism is necessary. Wilson used an ingenious arrangement of a falling weight, which first pulled out the plug *B* and allowed the expansion to take place, then let the particles into the chamber and finally make a contact which flashed on the arc light at the

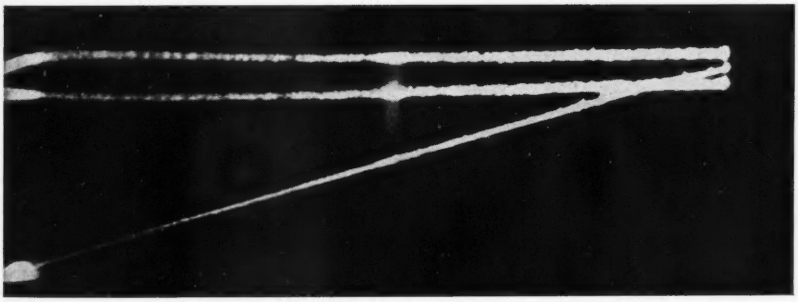


Track of an alpha particle

proper moment for taking the photograph. The lower figure is an interesting example of a photograph which shows one perfectly defined track and one partially dispersed. The radioactive element, actinium emanation, disintegrates into actinium A and an alpha particle. Within a time interval of the order of 1/500th of a second, actinium A again disintegrates, giving off another alpha particle. When the expansion was made the actinium emanation atom had already disintegrated and shot off an alpha particle whose track can be seen already dispersed as the two parallel heavy tracks towards the top and bottom of the photograph. The remaining atom, actinium A, had recoiled a small distance, which accounts for its not being exactly in the centre of the dispersed alpha tracks. Then the actinium A immediately ejected another alpha particle whose track, sharply defined, shoots across the picture diagonally.

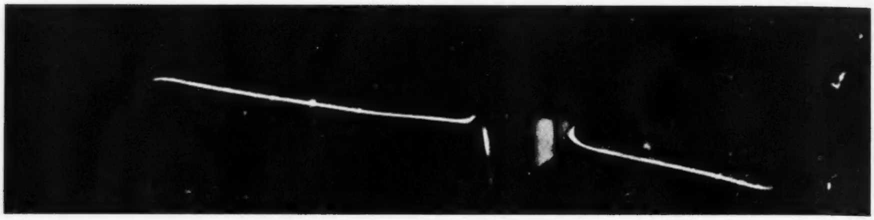
The beta particle is an ordinary electron whose velocity is much greater than normal. These beta particles are also often shot off in the disintegration of radioactive bodies. Although their energy may be of the order of a million volts, they are not so effective in ionizing matter because their mass is about 14/10,000 that of the alpha particle. Consequently their tracks are far less dense, and it is a relatively simple matter to count the ions formed in a given electron track. The figure above shows the track of a beta particle in a cloud chamber. The thin straight line of dots through the centre of the picture is the fast electron track. The other zig-zag lines are tracks of much slower electrons, unconnected with the passage of the fast electron through the chamber. The nuclear physicist to-day deals with other fundamental particles besides the alpha and the beta particles. Each of these has its own characteristic track. The photograph reproduced on p. 490 shows what happens in the case of the disintegration of lithium atoms.

Track of a beta particle



Tracks of alpha particles emitted from Actinium Emanation and Actinium A

The lithium target placed in the middle of the picture is bombarded with deuterons. Deuterons, heavy hydrogen atoms stripped of their electrons, have a mass and a charge each equal to one-half that of the alpha particle. On bombardment with deuterons, the lithium atom disintegrates into two alpha particles, whose tracks, going in opposite directions, may be seen in the photograph. Recalling that an alpha particle is a helium nucleus, we see that this is the picture of the formation of the element helium from the elements lithium and hydrogen, a true transmutation.



Tracks of two alpha particles emitted in the transmutation of lithium

The modern modifications of the cloud chamber are few. Wilson himself is responsible for the insertion of a rubber diaphragm instead of a piston. When the air below the diaphragm is exhausted the rubber diaphragm is sucked down and this provides the necessary expansion in the chamber above. The operation of the mechanism has changed considerably, and Wilson's falling weight has been replaced by an electrical timing system. After expansion these systems reset the cloud chamber so that it is immediately ready for another operation. In place of the single camera Wilson had already used two cameras set at an angle in order to give a stereoscopic view. Such a view permits accurate determination of the paths of the particles. In work with cosmic rays cloud chambers are used, but since experiments are often made on remote mountain tops and deep in mines, the operation of these chambers must be completely automatic. Usually they are arranged to take a sequence of pictures, thousands after thousands on motion picture films, in the hope of catching some interesting photographs. This necessitates subjecting all these photographs to the sharpest scrutiny. To make the task of the physicist lighter, a mechanism has been developed which allows operation of the chamber only when particles are inside it. This method utilizes the Geiger counter, a small cylinder about an inch in diameter, which will record electrically the passage of any charged particles through the cylinder. If one Geiger counter is placed above and another below the chamber, they can be arranged so that the chamber is set off only when a particle has passed through both Geiger counters, and thus through the centre of the cloud chamber. For such an apparatus to work properly an elaborate timing device is necessary, but these have been developed and automatic chambers are in operation. And so the experience of one Scotsman in a mist has led directly to electrons which can be trained to take their own pictures.

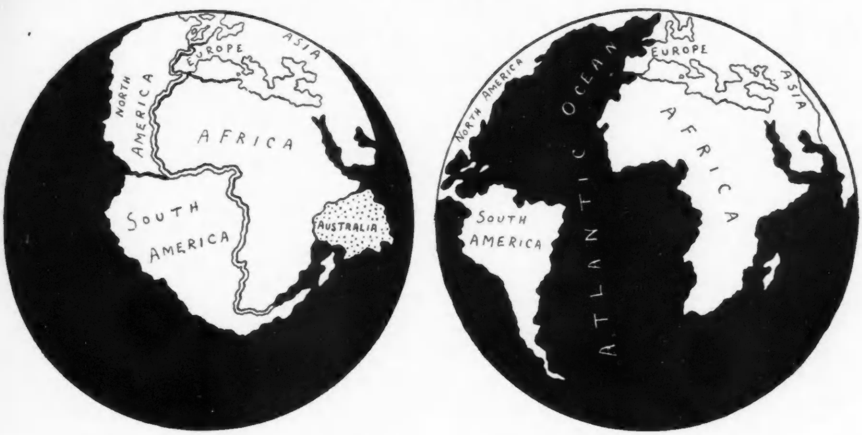
The references to Wilson's relevant articles are: *Philos. Trans.* A, **189**, 265 (1897); *Philos. Trans.* A, **192**, 403 (1899); *Proc. Roy Soc.* A, **85**, 285 (1911); *Proc. Roy. Soc.* A, **87**, 277 (1912).

INVITATIONS TO KNOWLEDGE. VI

Change in the Earth's Surface

By J. Robinson

The work of the geologist is to recover and trace the story of the earth, and by his work he shows us that however solid the lands of the earth appear, they are, in fact, restless and changeful. Many years of patient and exact surveying prove, for example, that the great mountain chain of the Swiss Alps is actually advancing to the north along a 300-mile front, causing the plains before it to sink into the earth, under its irresistible weight. The mighty Himalayas, the greatest mountain system of the world, are creeping, ever so slowly, to the south, crushing and riding over the foothills which stand in their way. These are hard scientific facts, yet is anything stranger, more wonderful, to be found in the fairy tales of Grimm or the magic of the *Arabian Nights*? The river bed of the Thames 10,000 years ago has been discovered buried underground 60 ft. below present sea-level. For nearly two centuries geologists have been watching the land in north-east Sweden actually rising out of the sea. And they have accurately measured the rate at which it is rising, which amounts to roughly 1 ft. in every 25 years. Not very far away in the south of Sweden and in Denmark, the land is steadily sinking into the sea. Nature here, in fact, is busy tilting the whole Scandinavian peninsula so quietly yet effectively that another hundred centuries or so will see the Baltic Sea drained of water and Sweden united by dry land with Finland and Esthonia. If you think 100 centuries a long time, remember that this period in the past life of the earth equals about 3½ *hours in the whole life of a man.*



The world according to Snyder before and after the separation of America from Europe and Africa

Sea shells, similar to those found on any beach to-day, can be picked from out of the rocks, which consist entirely of old hardened volcanic ash, near the summit of Snowdon, the highest mountain in England

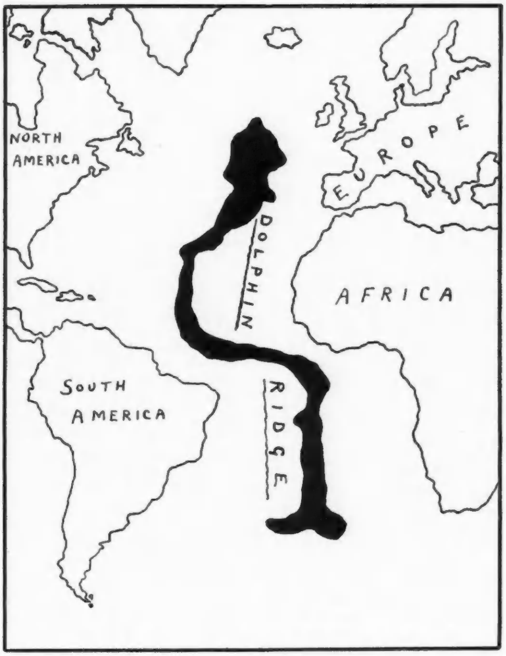
The rocks of Snowdon were once a sea bed

and Wales. The shells tell us that the rocks of Snowdon were once part and parcel of an ancient sea-shore or sea-bed, and the ash tells us that they were formed by volcanic eruptions in some long-vanished bygone age. That, in brief, is how geologists know that Mt Snowdon began its life as an active submarine volcano. During recent historic times even, several volcanic eruptions have broken out on the sea-floor.

Rivers are important economic assets of a country, but they can also be a means of its destruction, for they carry along with them a great deal more than just water. The Thames, for instance, carries no less than 1000 tons of dissolved chalk under London Bridge every day of the year, besides three times as much other solid matter, such as salt and sand, mud and gravel. The mighty Mississippi annually carries enough sediment to the Gulf of Mexico to cover the cities of Liverpool and Manchester with a layer 3 ft. deep. No railway system in the civilized world could possibly carry and discharge so enormous a load. Every year the river Rhone pours sufficient lime into the Mediterranean to make 300,000 million full-grown oyster shells. Flowing at only a couple of miles an hour, half that of an average man's walking pace, rivers can roll stones as big as an egg. Their moving force varies as the sixth power of their velocity, which simply means that if flowing twice as fast as usual they will be able to move objects 64 times larger or heavier than usual. That is why a stream ordinarily swift enough to roll only small

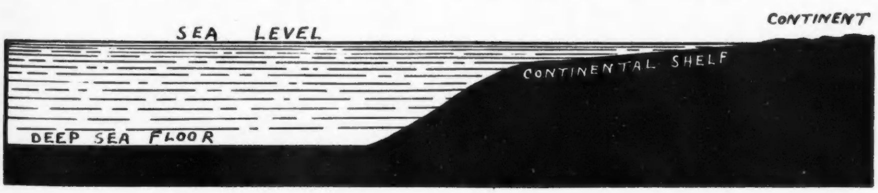
pebbles will in times of flood roll along boulders weighing a ton.

Now where does all this river stuff come from, this alluvial matter as it is called? How do rivers manage to get hold of such huge quantities of salt, sand, mud, stones and so forth? The answer is to be found in our very old familiar friend, the weather. Next to rivers, the weather is the principal destroyer of our lands. The ravages of the weather in general, and of stormy weather in particular, are startling almost beyond belief. Just as an iron nail left in the open air soon becomes coated with soft brownish rust, so do the exposed surfaces of even the hardest rocks, like granite, rust or crumble away to astonishing depths of 60 ft. or more.

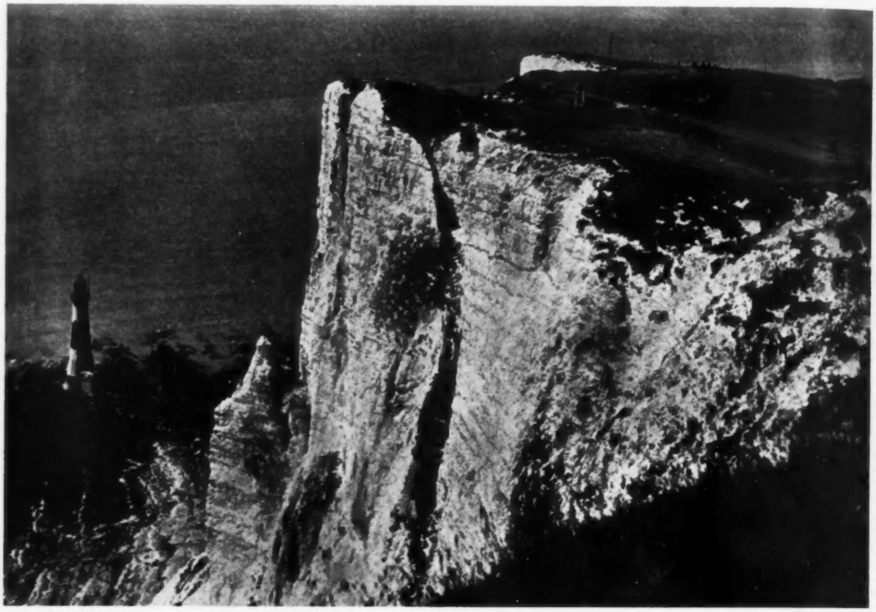


A mountain ridge which stretches for more than 7000 *miles along the floor of the Atlantic Ocean*

Next time you are among hills or mountains, notice the feet of the crags and you will see the silent destruction of a landscape at its beginning. You will see a litter of sharp-edged rock fragments of all sizes ranging from little chips to great chunks or boulders. These screes, as they are termed, have all been broken and splintered from the crag face by incessant attacks of wind and rain, sunshine, frost and snow. Geologists call this erosion, but erosion does not stop here. The same elements immediately begin driving the loosened rock fragments onward and downward, ever to lower levels, until they are eventually washed or blown into nearby brooks and streams which feed a river. They are always being further broken up during the journey, rounded off into pebbles by rubbing together, and even ground down at length to fine particles of sand and dust. Lime, chalk, salt and a host of similar substances are essential ingredients of many varieties of rocks and they are dissolved by



All the sediment and rock waste carried down by rivers is deposited on what is called the Continental Shelf, the submerged, gently sloping edges of the continental land masses. None of it reaches the deep sea floor.



Millions of years were needed for the Foraminifera to build up the chalk cliffs of Beachy Head

rain soaking down through the pores of the rocks. Even the fertile soil of lowlands and farm fields is but the moistened mouldered rock of hills and mountains halting a little while en route to its last resting-place, the sea bottom.

Good places to see the accumulating havoc of erosion in England are gently shelving tracts of coast-line such as Bridgwater Bay, the Dee mouth, or the Wash, where low tide uncovers banks of mud and sand running for miles. Without constant dredging, indeed, many harbours and river mouths would soon become too shallow and blocked to shipping by sedimentary accumulations. The Thames alone keeps washing into the North Sea something like 25,000 tons of English hills and fields every week. All told, Britain is being reduced to sea-level in this manner at an ascertained average rate of 1 ft. per 3000 years. Since the mean height of Britain is a mere 350 ft. or so, a simple multiplication sum tells us how long she can continue to live at this rate of destruction. Little longer than a million years will thus suffice to see the last bits of our native land vanish under the sea. There is, happily, nothing novel or alarming about the British Isles disappearing into the sea. Not these islands only, but all Europe, and all the continents of the world have been under the sea before at various times and for prolonged periods. In actual fact, most of modern Britain was made at the bottom of the sea; most of the rocks under our highways and houses were formed there out of the debris of previous, long-dead Britains—from the hardened, compressed mud and stones spread over primeval sea-floors by primeval rivers just as present-day rivers are spreading the self-same materials over present-day sea-floors. Journey from London to Manchester, or from Liverpool to York, or from Newcastle to Berwick, and you travel over nothing other than ancient, upraised

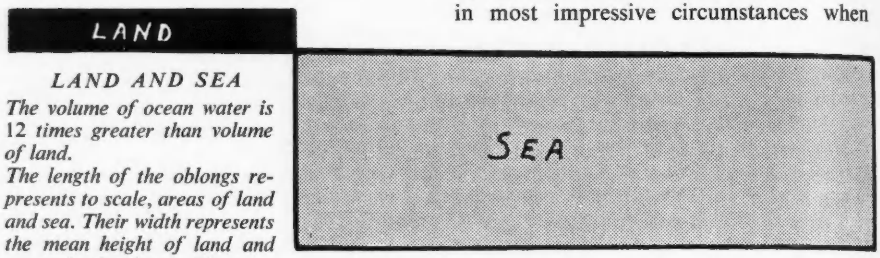
sea-bottoms. The beautiful white chalk rocks of the North and South Downs, the Dover cliffs, and many other districts are remarkable in so far as they consist not of mineral remains but of animal remains. They consist entirely of the hard limy remains of Foraminifera, a species of tiny marine animals who live in deep sea water. Indeed, the ooze at the bottom of the Atlantic Ocean to-day consists very largely of these very same Foraminifera relics. On dying, they sink to the ocean bed where the water dissolves away the softer fleshy parts and leaves the hard shelly parts to accumulate. Thus we know that back in the dim past, the English chalk rocks were forming and growing under at least 100 fathoms of salt sea water. This period in the physical or geological history of our country is known as the Chalk or Cretaceous Period, and during it over three-fourths of modern Britain was submerged. Half a dozen isles no bigger than the Isle of Man—that is a roughly accurate picture of ancient Cretaceous Britannia.

The shaded patches represent all that were the British Isles during the late Cretaceous (Chalk) period. Over three-quarters of modern Britain was then submerged somewhere about 80 million years ago.

What is left undissolved of each individual member of those strange little sea creatures, the Foraminifera, amounts to less than a mere pin-head of chalky matter. How many myriads of generations, then, must have died and gone to build up the colossal masses of our chalk hills and cliffs? How many must be contained in the famous Beachy Head alone, that steep and towering chalk headland 530 ft. high? Millions of years were needed for them to accumulate and to cement and consolidate by wetting and by crushing overhead pressure alike from water and the upper layers upon the lower. Millions of years more were needed to uplift them hundreds of feet into the air and sunshine. As a rule, Nature takes plenty of time over her jobs. She is always pulling down her terrestrial edifices and rebuilding them to other designs in other places. The fairest of landscapes must finally age and perish and make way for others: the ruins of the old are the raw materials of the new. Subsidence of land here, upheaval of land there. Everlasting and immovable as they look, mountains are comparatively short lived by terrestrial time standards, for the loftier they stand the more exposed they are to the onslaughts of the weather. The most diminutive ranges,

like those of north-west Scotland and Norway, were once the reigning giants estimated to be probably sixfold higher and bulkier than now. They are least and lowest now simply because they are among the oldest mountains in the world and consequently the most decayed. The Himalayas and the Alps are among the youngest. They are newly erected features of the earth's surface, and the most rapidly disappearing ones too. Celebrated peaks such as the Matterhorn and Everest are practically the work of just a single common element—frost; they have been shaped and sculptured almost entirely by alternations of summer thaw and winter frost which, at the same time, are the means, too, of their destruction.

In spring and summer this great drama of destruction can often be seen and heard in most impressive circumstances when monster, million-ton avalanches of boulders and earth rush and roar down their steep slopes.



LAND AND SEA

The volume of ocean water is 12 times greater than volume of land.

The length of the oblongs represents to scale, areas of land and sea. Their width represents the mean height of land and mean depth of sea. They are therefore in correct proportion to the cubic contents of land (above sea-level) and sea on the earth's surface.

Nobody notices any alteration in a landscape during his "allotted span" of 70 years, for the same reason that nobody notices any alteration in a fellow human being within the short space of a day or a week. Yet people and landscapes change beyond recognition and the human face actually changes more in a week than the face of the earth does in a century.

Reviews

A Biologist in Isolation

Dr Fraser Darling requires no introduction to the readers of *Discovery*, to whom several of the essays in this charming book* will be familiar. It is good when a biologist has the soul of an artist, for indeed, the scenes on which most of the essays are based are themselves vividly poetic. The very names, not only the Scottish ones, are rich in music. On the shoreline we read, "at their seaward limit grow the tangles, the carrageen and dulse and the thongweeds. How close is the dulse to the heart of the islander." Yet the practical man crops up at once. "Many of us carry some of the dried weed (dulse) to chew in moments of idleness and abstraction."

His description of a shoal of mackerel is of the same calibre. The man is to be pitied who knows this lovely fish only as in soused or grilled condition, and has never seen the beauty of the living creature, nor wondered at the working of the group-mind, seen in their iridescent shoals as wondrously as with starlings.

Dr Fraser Darling loves his marine mammals. In these days which have not yet sent the horrors of the whaling industry to join the slave-trade, it is good to read passages, so very few in literature, where whales appear as living sentient animals. To him they are friends "... the whale would come along... not in any cheeky or boisterous fashion, but quietly, as a collie might come over the hill with you". How little we know of their private lives. As the author remarks, the enormous face and tiny eye of Leviathan tell us nothing of the workings of that much-convoluted, high type of brain which lies behind the mask.

And he quotes two *loci classici* of the grandeur and dignity of the whale, Psalm 104, and

* *A Naturalist on Rona*, by F. Fraser Darling. (O.U.P., 7*s*. 6*d*.)

from *Moby Dick*, "...suspended in those watery vaults floated the forms of the nursing mothers of the whales".

The day must come when a more civilized posterity will regard with disgust the generation that can for gain torment to death with explosive harpoons these splendid creatures, which appear to be both affectionate and intelligent. Indeed, whaling is an industry worthy of the generation that has invented gas-masks for babies.

But the most interesting chapter, I think, is the description of Ron Mor, the Great Seal. Dr Fraser Darling went to stay a few weeks among the seals and share their island home. He learnt a trick of the voice that enabled him to win their sympathy, as a man of understanding may hold converse with a cat, but he will keep that secret, for it enabled him to come closely into their lives, and in the wrong man that might lead to tragedy. And, like whales, seals have had more than their share of tragedy.

In this not very long book there is plenty to interest anybody. Both historian and archaeologist will enjoy the chapter on the former inhabitants of Rona, and of the remains of the buildings left by St Ronan. The former abandoned the island, or were starved to death, in the seventeenth century. Sir Donald Munro wrote of them in an unpublished manuscript, "ane little ile callit Ronay...inhabit and manurit (worked) be simple people". He wrote that in 1549, but before the next century was out they were gone. Like all simple people, they were of hospitable nature, but misfortune came from outside. A plague of rats came ashore from a ship and consumed all their scant sustenance, and some seamen landed and stole the island bull.

There are essays too on the display of birds, on the social life of animals, on the mystery of antler growth and other subjects, often little known to the general reader. It is all written in a style of dignity and charm, spiced with a sprinkling of words unfamiliar to the southern reader.

I confess that I am left to guess the meaning of the airt of the wind, a little sheep fank, the brackish dubs, a peat hag, a thrutching movement, a smatching, dunts of air, and a quirk.

All the photographs are good, several of special beauty. Yet I think my favourite is the portrait of the benign old gentleman on the frontispiece and jacket. MALCOLM BURR

A House in the Woods

THE authoress is well known for her delightful books on animals and birds. This one* consists of forty-four photographs, with supplementary footnotes. A woodman built a thatched hut in the wood where he worked, and the pictures show the creatures and flowers which became his companions. Though the photographs are not all of equal merit, most of them are very good indeed, particularly those of squirrels, voles, dormice, hedgehogs and dragonflies. Presumably this little volume is intended for children, but it is a delightful book for all.

E. W. H.

* *A House in the Woods*, by Phyllis Kelway. (Black, 3*s*. 6*d*.)

Letters from Readers

Nutrition and Health

In our June issue, we published a letter and a reply about the articles on "Nutrition and Health" which ran in Discovery *for some months. Below we print some further correspondence between Mr P. F. Fyson and Mr C. H. March, author of the series.*

Mr March has met my points in part by denying them, in part still using, as books on nutrition always do, the body-building and heat-producing properties of food materials as their chief functions. I am wondering, however, whether he meant this account of the role played by protein and carbohydrate or fat in the animal metabolism to be really the whole story.

Schafer, once a big noise in the physiology world, used, I remember, to insist that all food materials became so intimately part of the living protoplasm, and had to be before use, that it was impossible to assign to them special body-building or heat-producing destinations. This appears so reasonable a view that I have always been surprised that its implications are ignored in popular expositions of nutrition. For may it not be that the protein molecule with its so labile constituent nitrogen and the facility with which it forms groups of varying composition, takes a quite definite part in the combustion of carbohydrates in the living cell? It is rash, I know, to quote one's personal experience on a scientific

question, for one lays one's self open to the withering criticism "only subjective"—but I give two of mine for what they are worth. When doing outdoor inspection, which meant 6 miles on a bicycle and much walking about, before breakfast, I used to find, quite definitely, that I was less tired and famished on my return at nine o'clock, if I had confined my "chota" to tea and toast, than if I had "fortified" myself with an egg as well. This I came to think must be because the abundant proteins of the egg burnt up the carbon compounds of the toast or body fat more quickly. On other occasions too, e.g. before a long walk, it was better to avoid food rich in proteins. Again, as a boy at school, I found a plate of cold roast beef at dinner, and plenty of it, with a minimum of potato, the best preparation for a rugger match. Potatoes and pudding, rich though they might be in combustible carbohydrates, were fatal to quickness. If we assume that proteins definitely help in the metabolism of the cell —and does not the customary reduction in the eating of carbohydrates, but not of meat, as a cure for obesity, point to this same idea?—we can understand why in colder climates men eat more meat, for they need a more rapid katabolism to maintain the body temperature. "Pace", Mr March. I am sure children do eat more carbohydrates in proportion to protein than adults, and this, I take it, is because being younger they enjoy a more efficient cell mechanism, so that less protein is necessary to actuate the required combustion of starch, sugar or fat.

As to "Night Starvation", I only followed Mr March himself in using the term: I never imagined that he supposed any one meant by it true starvation. It is, of course, a clever exaggeration to boost a night-cap. I became aware of the value of food last thing at night twenty years or more before I first saw (I think the first) "night cap" advertisements, by the fresher feeling on the morning after Saturday night's dancing (which, ending at midnight, allowed of no supper interval) when I had drunk the excellent hot soup the club used to provide after.

P. F. FYSON

THERE is no doubt that carbohydrates enter into the composition protoplasm and must indeed do so before they can be metabolized. They are broken down so rapidly, however, that they are never present in large amounts. The analysis of a piece of lean meat (muscle) will show about 75–80 % of water, 15–20 % of protein, 1 or 2 % of fat and about 1 % of mineral substances. There is usually less than half of 1 % of carbohydrate present, so that it is obvious that it is not a very important body builder. On occasions excess carbohydrate may be changed into fat by the body and stored as such. The liver is the only organ which stores appreciable amounts of carbohydrate and it rarely contains more than 5 or 6 %. There is no doubt that the constituents of food react with each other in the body.

Mr Fyson makes a mistake in assuming that food just taken into his stomach is going to play an immediate part in the production of energy. It takes a number of hours for a meal to be digested, absorbed, conveyed to the tissues and taken up by them. Only when it has reached this stage can it be used for the production of energy.

In his previous letter Mr Fyson says, "Why do children...require less meat than adults?" To this I replied, "They may not need as much meat, but they actually need more proteins." Children are: (1) Building up their bodies rapidly; therefore they require more protein than adults who have stopped growing. (2) Using up more energy as a result of their greater activity and therefore requiring a greater proportion of carbohydrate in their diets. Actually it is invidious to compare a child's diet with that of an adult because the adult's food requirements vary tremendously with the nature of his employment.

I have no doubt that the consumption of hot soup after a dance would cause a temporary rise in blood sugar due probably to a mechanical effect and to the heat, but I would like to point out that the food value of soups is almost negligible. I fail to find any reference in my articles to "night starvation", so that I cannot quite understand Mr Fyson's reference to my use of the term.

C. H. MARCH

drates
n and
meta-
pidly,
large
f lean
% of
of fat
There
carbo-
hat it
. On
y be
red as
which
drate
6%.
nts of
ly.
ming
ch is
pro-
er of
rbed,
p by
stage
ergy.
says,
than
y not
need
lding
ey re-
have
nergy
and
ortion
lly it
with
food
h the

on of
tem-
ly to
, but
value
find
star-
stand
term.
RCH